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# Large Steel Arch Roof Eighth Coast Artillery Armory, New York City

One of the largest steel arch roofs in existence is nearing completion at Jerome Ave. and Kingsbridge Road, New York. It forms the drill hall of an armory for the Eighth Coast Artillery (New York State militia). Drawings of the framework are shown herewith. The erection, equipment and procedure were described in ENGINEERING NEWS, Jan. 22, 1914, pp. 163 to 166.

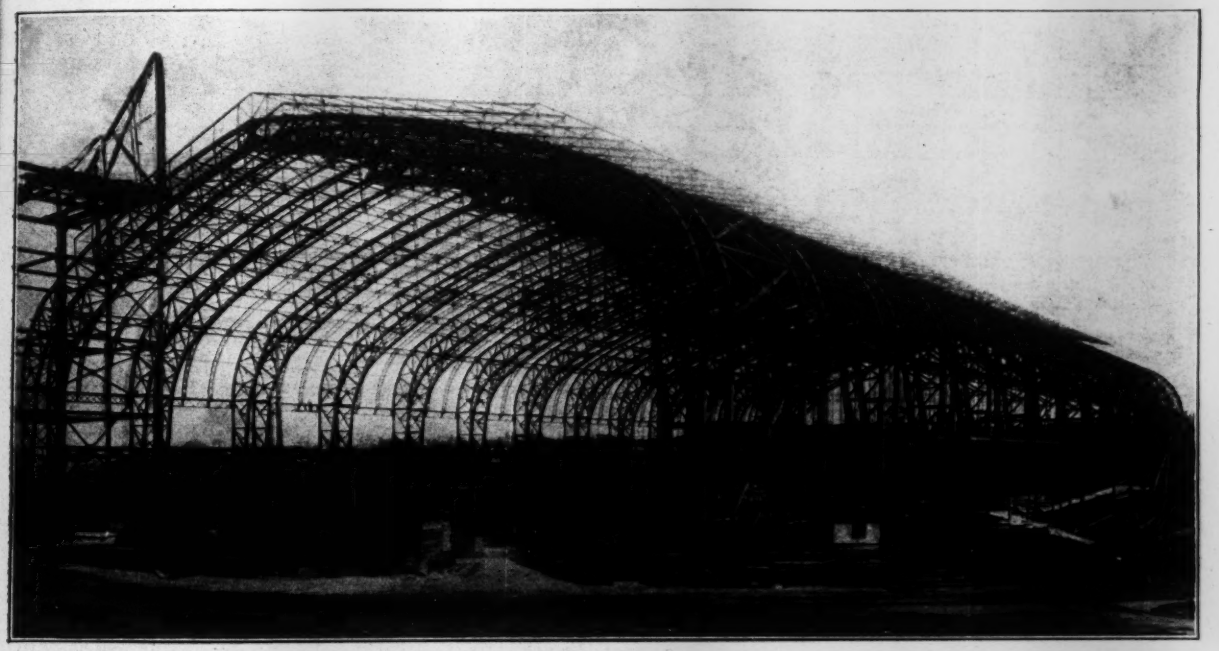


FIG. 1. PARTLY COMPLETED ARMORY FOR THE EIGHTH COAST ARTILLERY (NEW YORK STATE MILITIA), NEW YORK CITY

The general dimensions of the structure are: Span center to center of end pins, 288 ft. 10 in.; rise center to center, 102 ft. 7½ in.; length center to center of end trusses, 520 ft. The weight of steel in the roof framework is about 5000 tons; each of the 40 arch trusses weighs about 100 tons.

The trusses are grouped in braced pairs forming towers 10 ft. wide. The intermediate spans are generally 35 ft. (32½ ft. at the ends). The towers are fully braced in top and bottom chord, but only the two intermediate bays nearest the end contain bracing. The roof support is by lattice-girder purlins and jack-rafters, carrying wooden secondary purlins on which is nailed wood sheathing to support composition roofing. A monitor 8 ft. high covers the middle two-thirds of the width, but the purlins and jack-rafters remain in the plane of the main roof, and monitor frames come over each jack-rafter, the monitor posts footing on the purlins and jack-rafters. The monitor rafters are each two 7-in. channels, on which the 4x8-in. timber secondary purlins rest.

The chords of the arch truss are of simple T-shape throughout, giving direct connection of the web members to the web-plate or stem of the chord. The heaviest chord section occurs in the haunch of the bottom chord, where the outline of the truss curves sharply. It consists of two angles 8x6x$\frac{13}{16}$ in., one web-plate 16x⅞ in., and three covers 18x⅝ in., a total cross-sectional area of 73 sq.in. The web members are generally of moderate section, being made up either of two angles or of two channels.

The shape of the arch, as shown by the drawing, involves a practically vertical end portion (the outer face is plumb) connected by a sharp curve with the sloping roof portion. In the sharply curved part of the truss, it was considered desirable to curve the chord instead of running it straight between panel-points; this not only gave a smoother appearance but reduced the number of splices or connections in the chord. On the other hand, it made the haunch sections between splices too large to ship, so that they had to be assembled in the field.

In assembling these sections, it was necessary to get the

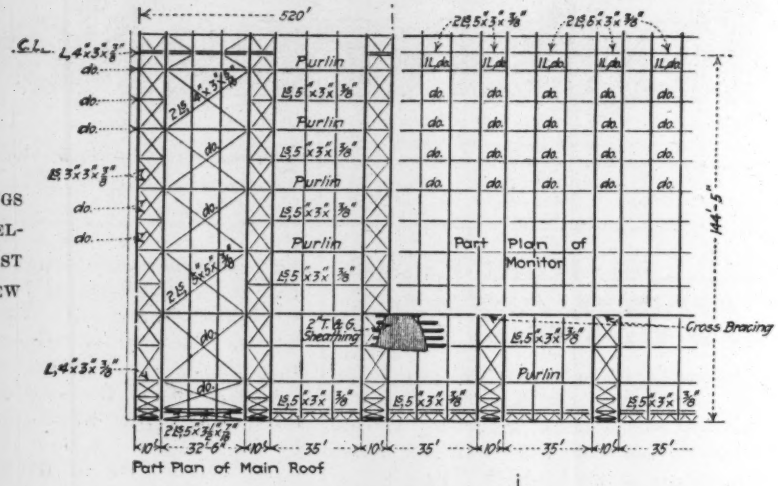
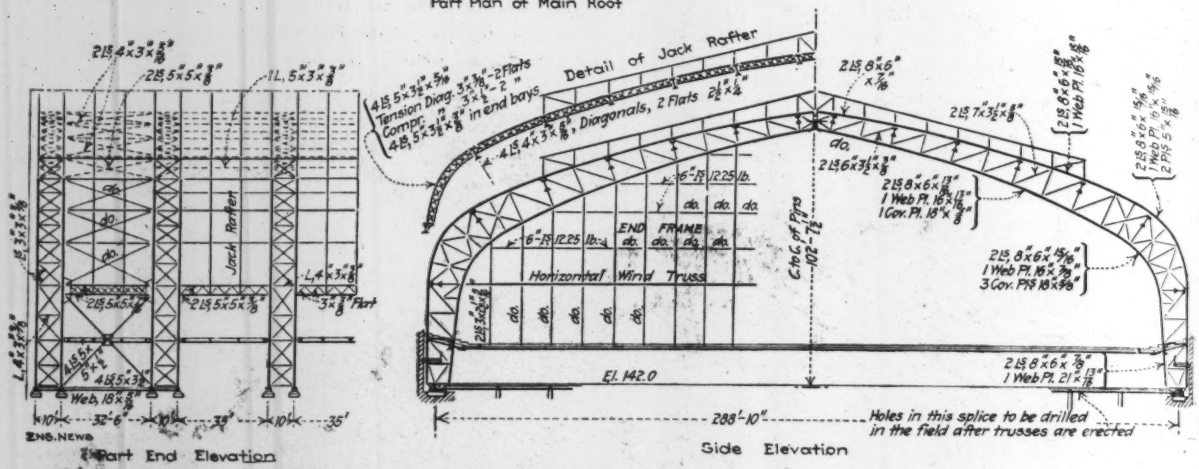



FIG. 2. GENERAL DRAWINGS OF DRILL-HALL STEELWORK, ARMORY FOR EAST COAST ARTILLERY, NEW YORK CITY




(Location of wind truss and hanger detailed below shown in "Side Elevation" in Fig. 2 above.)

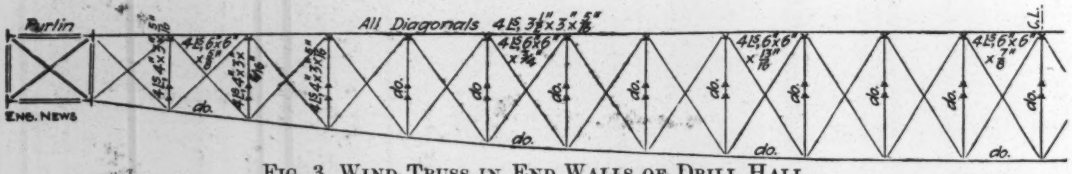



FIG. 3. WIND TRUSS IN END WALLS OF DRILL HALL

chord splices into full bearing, since the butting ends are counted on to transmit the compression. At the same time, however, it was necessary to get the web members adjusted exactly right, in order to make the arch true to shape. For this reason, all field connections in the haunch sections were built with subpunched holes, match-reamed in the field after drawing the parts into exact position to give the true shape of the arch.

The top chord splices in the haunch, which have to take tension under certain load conditions, are proportioned for the tension, without regard to the maximum compression across the joint.

The drawings in Fig. 5 show also the pin details used at foot and crown. The pin at the foot engages the end of the arch tie, which is built into the floor of the drill hall. This tie, made of two channels spliced for tension, serves both as floor beam and as arch tie. It was erected and riveted up when the floor steel was set, but the end length was not spliced to the remainder until the lower section of the arch was in place on the shoe and the pin driven. When this assemblage was made and its exact location verified, the splice in the tie, which had blank holes in one side, was drilled to match and riveted up.

The cast-iron arch shoes rest on concrete piers carried to rock. The detail construction of the piers differs with the depth of rock below grade, which varies from a few feet at one corner of the site to some 60 ft. at the opposite corner. Generally, the two piers for a tower were kept separate in their upper

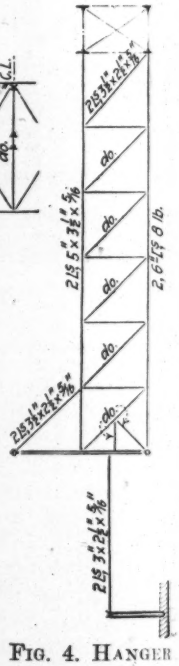


FIG. 4. HANGER FOR END WALL

halves merging into a single broad pier below, the upper (separate) parts were connected by a curtain wall on the outside. The piers were proportioned for vertical load and earth pressure, but not for any lateral forces due to the arches.

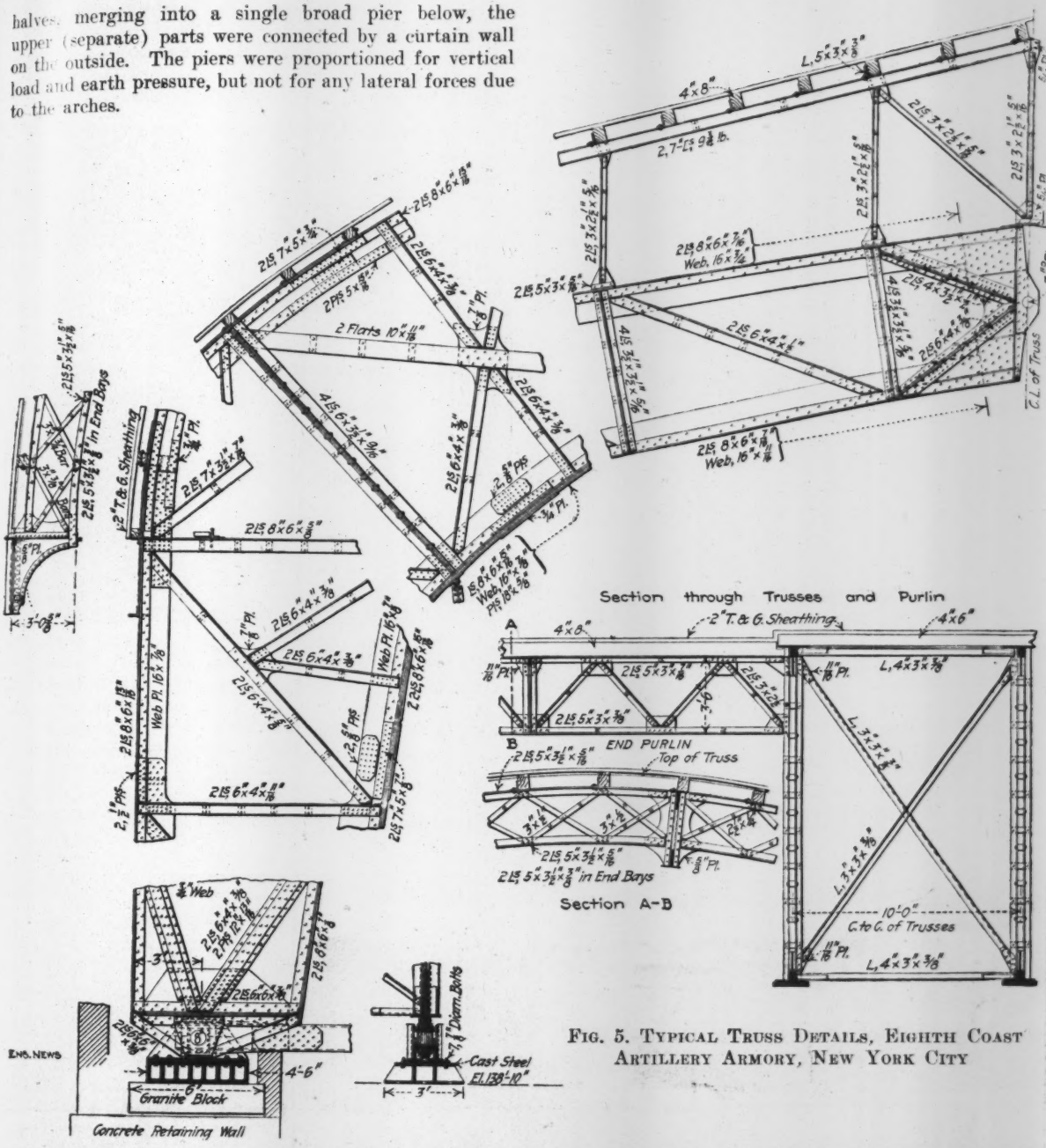



FIG. 5. TYPICAL TRUSS DETAILS, EIGHTH COAST ARTILLERY ARMORY, NEW YORK CITY

No provision for expansion was made between arch and pier, in spite of the great span. The designers expect that expansion will be small because of slight temperature variations in a structure of this kind; and to give some opportunity for slight expansion movement, the bottom and top faces of the shoes were planed with tool traveling in the transverse direction so as to facilitate sliding on the granite cap of the pier. The roof framing contains no provision for expansion longitudinal to the drill-hall.

The end walls of the hall are mainly of glass, practically the whole lighting of the hall being obtained through these ends. The wall brickwork extends 40 ft. above the floor, while the upper 50 to 60 ft. are glass. The end framing, comprising a horizontal wind truss and vertical hanger frames, is shown in Figs. 3-4. The weight of this framing is supported by the end arch.

An article describing the erection of this roof and showing several views of the trusses in process of erection was published in ENGINEERING NEWS, of Jan. 22, 1914, pp. 163-166.

The Eighth Coast Artillery Armory was designed by Pilcher & Tachau, architects to the Armory Board, New York City. The Gunvald Aus Co. designed the steelwork. W. J. Conner has the general contract for the erection of the building. The Cambria Steel Co. fabricated the steelwork, and the Pittsburgh Construction Co. erected it.

# State-Highway Organization and Work in Connecticut*

Organization is "the systematic union of individuals in a body whose officers, agents and members work together for a common end." The organization most nearly perfect, it naturally follows, is the one whose officers, agents and members have its interests so thoroughly at heart that personal aims or ambitions are subordinated to the common good. Emerson has said "A great institution is the lengthened shadow of one man." This being true, the success of the organization depends largely on the man who is the directing force thereof. Confidence between the head of the organization and the subordinates must be mutual. If there is an absence of confidence, the seeds of ultimate failure of the organization already have been sown.

In the organization of the Connecticut Highway Department there is a coördination of interests between the Highway Commissioner and his subordinates. There are no secrets in the department; the business transacted by the Commissioner is known to the subordinates; and good feeling exists in all of the various branches of the department. This briefly summarizes the attitude of the Commissioner towards his force in the office and in the field, and reflects the feeling which all of the subordinates entertain toward the "Chief."

## Appropriations

At the biennial convening of the state legislature, various committees are formed, and among these is one known as the Committee on Roads, Rivers and Bridges. To this Committee are assigned all matters relating to state-road improvement and maintenance. Hearings are held on these several propositions, and the Highway Commissioner is extended the privilege of explaining the needs of his department, and what he considers desirable in the way of appropriations to successfully carry on his work.

All of these hearings are public and any person who may have divergent views is given an opportunity to tell wherein he may differ from the policy outlined by the Highway Commissioner. The Committee, after deliberation, makes its report to the legislature. Sometimes, of course, the members of the General Assembly (or a majority thereof) deem it expedient to modify the requests of the Commissioner, and an amended bill becomes law.

Appropriations for new construction, maintenance and administration become available on the first day of October succeeding the meeting of the legislature. The appropriations for new construction are divided into two classes, State Aid and Trunk Line.

State Aid roads are those main highways, for the improvement and maintenance of which the towns are re-

FIG. 1. TRUNK-LINE HIGHWAYS OF CONNECTICUT

FIG. 2. CONNECTICUT HIGHWAY OF BITUMINOUS MACADAM; ROAD IS SUBMERGED DURING SPRING FRESHETS

*Contributed.

quired to contribute a part of the cost. The Trunk Line highways are those roads designated by the legislature for which the state pays the entire cost of construction and maintenance.

In the matter of highway improvement, the State has acted on the supposition that the financially weak towns should receive a greater degree of aid than those communities having larger resources. Acting on this basis, towns having a grand list (or grand levy, as it is known in some states) of $1,250,000 or less receive seven-eighths of the cost of the improvement of such roads as the department may elect to improve, while towns having a grand list (or grand levy) of over $1,250,000 receive only three-quarters of such expense. The law provides, however, that $20,000 shall be the maximum amount any town may receive during a two-year period.

FIG. 3. A CEMENT-CONCRETE ROAD BUILT UNDER THE SUPERVISION OF THE CONNECTICUT STATE HIGHWAY DEPARTMENT

After the legislature has determined the amount of money to be appropriated for State Aid work, the highway department notifies each of the 168 towns and cities of the amount of money available for State Aid improvement, and requests the towns to hold town meetings to determine to what extent they will participate in the distribution of this State Aid fund.

A time limit is fixed for the filing of applications (usually Oct. 31) as the meetings in most instances are held on town election day, which is the first Monday in October. At the expiration of the time limit, the highway department determines how much money has been requested by the towns having made application. The amount of money available never has been sufficient to meet the requests of the towns.

In October, 1913, the towns were notified that there would be $1,000,000 available for two years ending Oct. 1, 1915. The towns requested an aggregate allotment of $2,800,000. With only $1,000,000 to apportion, it was necessary to scale the requests of the towns to come within the amount of money available, which meant that those towns asking for $20,000 for two years received only $8000. This, in itself, is proof of the popularity of the State Aid plan as carried out in Connecticut.

In addition to the State Aid fund, the legislature of 1913 made an appropriation of $2,000,000 for the improvement and maintenance of Trunk Line highways. This sum has been equally divided: one-half being set apart for the construction of new roads and one-half for the maintenance of the roads heretofore constructed. In addition to the $1,000,000 above mentioned, the money received from automobile licenses, amounting to approximately $400,000 a year, is added to the maintenance fund.

The accompanying map shows the Trunk Line highway system. The double lines indicate roads already completed, while the lighter lines show those roads upon which the department will work in the future. There are 1420 miles of highway included in the entire trunk-line system. Of this amount, 900 miles have been improved in a more or less permanent manner, leaving a balance of 520 miles uncompleted. The estimated cost per mile for completing this trunk-line system is $15,000, which would mean an expenditure for building these roads of $7,800,000. This estimate contemplates the use of bituminous or cement-concrete pavement only on part of such roads, approximately 150 miles.

There is also an appropriation of $100,000 a year for the maintenance of State Aid roads. In this class of maintenance, the towns are obliged to refund one-quarter of the cost—which means about $125,000 a year for the upkeep of the State Aid roads.

### SCHEME OF ORGANIZATION

The general scheme of the organization of the Highway Department is this: a Highway Commissioner, who has general supervision over all the work of the Department; a Deputy Highway Commissioner, who has charge of the construction work. He also has charge of the engineering corps inside the office and the eight Division

Engineers. There is a Superintendent of Repairs, in charge of care and maintenance. There are nine District Supervisors of Repairs, who are directly responsible to the Superintendent. A Chief Clerk has general oversight of the clerical work of the office.

To prevent a duplication of, or a conflict in orders, the present Commissioner, Charles J. Bennett, early instituted a system under which the heads of all branches of the department are kept in constant touch with his decisions, interviews and orders. The Commissioner, at the end of each day, when in the office, dictates a detailed report of interviews, decisions, suggestions, etc. Copies of this report are distributed in the office so that all may have access thereto.

Any matters pertaining to a particular branch of the work is immediately attended to by the head of that branch and proper notation made on the report. The heads of all departments submit similar reports and these, too, are distributed. When on the road, the Commissioner is accompanied by a stenographer who takes notes of conversations with contractors, division men, officials and others. Upon his return to the office these notes are written out and distributed for the information of the subordinates.

All letters are written in triplicate. One copy is filed for future reference. The third copy is given to the Chief Clerk, whose duty it is to read all such communications and keep himself so thoroughly informed of the business of the department, that mistaken orders or information not in harmony with the general policy of the department may be held in abeyance until the author of such letter is advised of the conditions and corrections are made. After the Chief Clerk has read these letters, they are distributed in the same manner as the general notes. They are then returned to the Chief Clerk for inspection. Letters relating to the work of any Supervisor or Division Engineer are sent to him for his information.

In addition to this general scheme of advising the field men of the details of the work, monthly meetings of the Division Engineers and Supervisors of Repairs are held in the departmental offices in Hartford. At these meetings, there is a general discussion of all matters pertaining to the various branches of the work. The Commissioner invites suggestions and recommendations. There is no embargo on discussion and each and every man is at liberty to express his personal views.

In addition to his work in the office, the Commissioner usually spends the last three days in each week on the road. During the busy season, the Deputy Commissioner is on the road practically all of the time. The same is true of the Superintendent of Repairs. A general conference is held upon the return of the Commissioner and the others to the office, during which time plans are formulated for the conduct of the work, criticisms are offered and suggestions made, all of which tend to augment the harmony which exists throughout the department.

FIG. 4. A SECTION OF THE BOSTON POST ROAD, FAIRFIELD AVE., FAIRFIELD, CONN., SURFACED WITH BITUMINOUS MACADAM

### UNIT SYSTEM OF LETTING CONTRACTS

Formerly the linear-foot basis only was used for letting all contracts for road work—a price was asked for construction of the road at so much per linear foot, which included all grading, culvert work, etc., and the application of a surface treatment of any type specified. Lately all of the work advertised has been upon a unit basis (cu.yd. of grading; sq.yd. of road material in place; cu.yd. of masonry; lin.ft. of pipe culverts, etc., the standard proposal form has provision for 46 such items, for

which the contractor bids per unit, agreeing to accept such a unit price for whatever quantity the final estimates show).

Contractors themselves say that this is the most satisfactory plan, as there is no possibility of buying a "pig

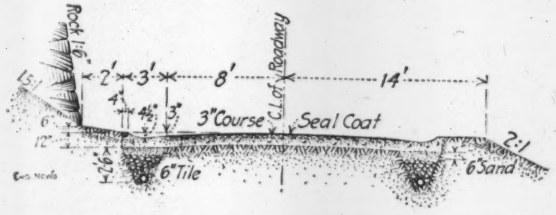



FIG. 5. CROSS-SECTION STANDARD 3-IN. BITUMINOUS CONCRETE ROAD, CONNECTICUT HIGHWAY DEPARTMENT

in a poke." From monthly estimates of the Division Engineers the Department makes payments to the contractors on certificate of the Commissioner and the Deputy Commissioner.

In preparing work for advertising, the designing department uses information received from the Division Engineers, who make approximate estimates. After bids are received, they are turned over to the designing department and two independent computations are made. These computations are then reviewed by the Highway Commissioner and the Chief Draftsman. If the work proposed is in the State Aid class, the Commissioner communicates with the selectmen of the town in which the work is to be done and notifies them of the estimated cost of the work and the name of the successful low bidder. If these are satisfactory to the town, the contract is awarded.

### ENGINEERING AND SUPERVISION

All engineering work is under the direct charge of the Deputy Highway Commissioner and to him reports are made by the Chief Draftsman, who has charge of the engineering work in the office; also by the Division Engineers, who are in charge of the work of actual construction. Surveys of roads to be improved are made by the Division Engineers. Such surveys include a statement of the local material available, character of the soil and other details of assistance to the designing department.

The Division Engineers are in charge of the Inspectors who make their reports to them direct. Weekly reports are also furnished by the Division Engineers, which give to the Commissioner and the Deputy a very definite idea of the progress of the work and indicate whether a contractor is pushing his work as rapidly as possible. A typical progress report is given (Fig. 2), showing a theoretical progress curve (speed the contractor should maintain for the best economic results) and the actual progress of the work as done. These reports have proved very valuable to the department, and incidentally to the contractor as well.

### FINAL ESTIMATES

It is the aim of the department to pay a contractor all to which he may be entitled at the time due and keep within the 85% provided for by the contract. The unit system makes this more easy of operation than the old linear-foot basis. After the Division Engineers have submitted their reports and estimates, these are reviewed by the Commissioner and his deputy, as heretofore stated, and checks are mailed to the contractor on the 15th of each month.

### ACCOUNTING DEPARTMENT

Early last fall a new system of accounting was installed in the department. Under this system, it is possible at all times to give the Commissioner a statement of the amount of money available in each appropriation and also a statement of the liability of the department for various uncompleted work.

After payments are made the 15th of each month, a list of contracts is prepared, showing the contractors name, the town in which his contract is, the total amount of the contract, the amount paid to date and the ratio of total payment to the total amount of contract in percentage.

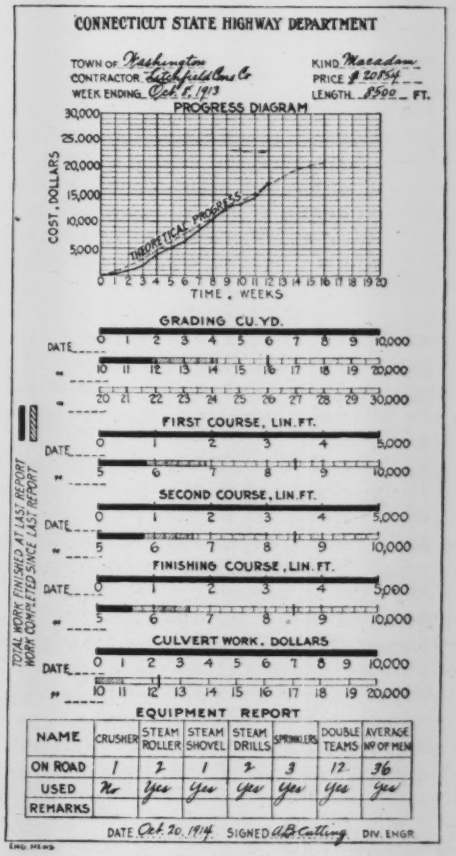



FIG. 6. PROGRESS DIAGRAMS; CONNECTICUT STATE HIGHWAY DEPARTMENT

This statement is furnished to the heads of the department, the Division Engineers and Supervisors of Repairs with a request that they be compared with their own estimates, and discrepancies reported. In this way it is always possible to check the figures once in each month and prevent errors.

The first of each month a trial balance is taken, and this balance is checked with the accounts in the comptroller's office. This trial balance shows the amount of

money available in each of the funds, the amount due from towns for refunds, the liability to each of the contractors and enables the Highway Commissioner to determine if the rate of expenditure is excessive. This is particularly desirable as the appropriations are made to cover a stipulated period of time.

In addition to the above system of book-keeping, there are graphic charts of expenditures kept, on which the total appropriation is plotted with a theoretical curve of expenditures, in which the ordinates are expenditures in dollars and the abscissas are time elapsed. These theoretical curves for the different appropriations are plotted according to the geographical location of the work for which the appropriations are made, and at the end of each month the actual expenditure of money is similarly plotted on the same chart, and a visible comparison reached immediately. A glance shows just how the rate of progress compares with the theoretical progress that should be had. The aim has been to reach a system whereby it is practically impossible for the department to over-expend unknowingly on any appropriation.

### Conclusions

The various reforms indicated in the foregoing have worked to the mutual advantage of the department and all those who have business with the State Highway Commissioner. In the first place, all of the subordinates of the department are kept in close touch with the various details of the work and they have an opportunity to be immediately informed of any orders or decisions made by the Commissioner.

A system of inspection is gradually being built up whereby a corps of inspectors is continuously employed, making it possible to get experienced men and to keep them interested in the work and to secure the best results. The value of experienced inspectors on construction work is evident.

The unit basis of letting contracts, as indicated, has removed the possibility of friction between the contractors and the department as they are paid for actual work done up to the limit of 85%, as provided in the contract.

The accounting system affords an opportunity for the Commissioner and all others to determine at short notice the financial condition of the department.

The Division Engineers have been invested with responsibilities and authority; an appeal from their decision, in order to be entertained, must be based on something more tangible than a fancied wrong.

Information coming into the Highway Commissioner's office is epitomized by the heads of the various branches and transmitted to the Commissioner in condensed form. He then is able to determine, without perusing a mass of details, the probable value of any proposition, make his decision and have it duly executed by the proper authority.

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**A Test for Natural Asphalt** has been devised by E. C. Tailler, of the Department of Public Works, Borough of Manhattan, New York City, and is described in the "Journal of Industrial and Engineering Chemistry" for April, 1914. The test is based on the presence in all natural asphalts of a number of organic acids or acid salts, which escape on distillation, and also upon a certain amount of saponifiable oils. Mr. Tailler describes methods of making chemical tests in accordance with the above principle, by which he claims it is comparatively easy to determine certainly whether a given asphalt is a residue from an asphaltic oil distillation or is a natural asphalt from Trinidad or Bermudez.

## A Simple Volume Regulator for Air Compressors

A new regulator has been devised for air compressors to control in simple manner the amount of air drawn in, in accordance with the demand for compressed air but without choking the inlet, without creating high temperatures or causing excessive waste of power. The scheme has been applied to compressors with either poppet or piston inlet valves. The suction valves can be used for regulation, being kept open during a part of each compression-discharge stroke and allowed to close when the air trapped and remaining is sufficient to satisfy the demand for compressed air. The discharge valves can be used for regulation instead, in that case remaining open during a part of the suction stroke and closing when the compressed air returned is sufficient after expansion to leave room only for the needed quantity of fresh air.

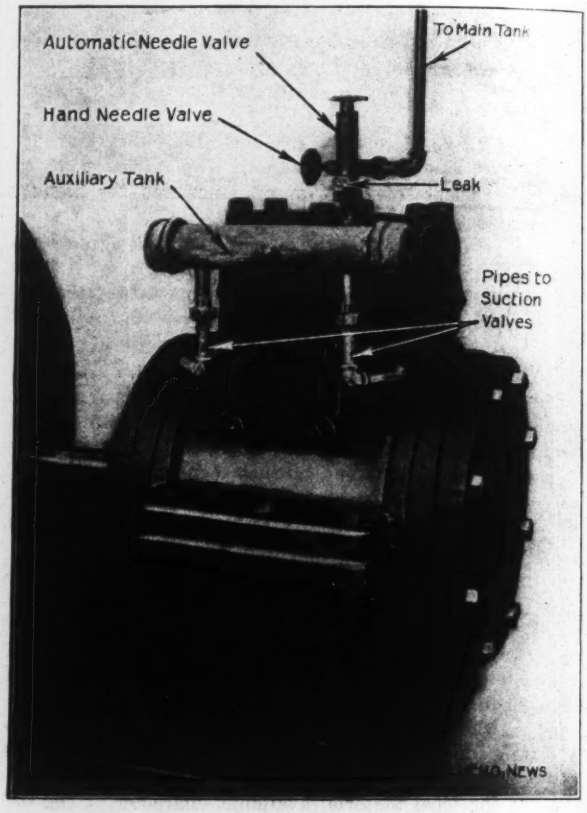



Fig. 1. Air Compressor Fitted for Wikander Volume Regulation

Application to the suction valves of an ordinary poppet-valve compressor are shown by Figs. 1 and 2. The valves have springs which tend to close them and pistons which tend to open them when sufficient pressure is applied. These valve cylinders are connected to an auxiliary tank and this in turn communicates with the main tank through (a) an automatic needle valve with a "leak," and (b) a hand-adjusted needle valve.

When this compressor (Fig. 2) is working at constant partial load, the automatic needle valve will admit some air to the auxiliary tank and this will escape through the "leak," keeping the pressure in the auxiliary tank and

valve pistons constant. The valves will close at a time in the discharge stroke when only the amount of air consumed will be compressed.

Increase (or decrease) in consumption will cause a momentary and small decrease (or increase) in main tank pressure so that the amount of air entering the auxiliary reservoir will decrease (or increase) lowering (or raising) the auxiliary-tank pressure and that in the valve pistons. The valves cutoff on the discharge stroke then earlier (or later) to increase (or decrease) the amount of air to be compressed and a new equilibrium is established.

The adjustable needle valve admits to the auxiliary tank only just enough air to keep the pressure there and in the valve pistons such that the compressor can operate at maximum capacity (without the suction valves opening during the discharge stroke). If more air enters through the automatic needle than can escape out the leak, the compressor capacity is reduced by the suction valves remaining open during part of the compression stroke, the open period depending on the pressure rise in the auxiliary tank.

Application of the scheme to the discharge valves of a piston-inlet compressor is shown in Fig. 3. When the compressor carries a constant partial load, air enters the needle-control chamber through a pipe and overcomes the tendency of the spring above to raise the needle-control piston. This last bears on a pin carried by the needle piston itself and prevents its rising far under main-reservoir pressure admitted to the needle chamber. The rise of the needle is limited by the pressure above the needle-control piston and only as much air will enter the auxiliary reservoir as escapes out the leak. The pressure in the auxiliary tank then must be slightly less than that in the main tank and passage into which the discharge valve opens. This pressure difference inside and outside the valve will hold it open after the discharge-compression stroke is completed, and it will stay open during the following suction stroke until a certain amount of the compressed air returns and expands to intake pressure. The fresh air drawn in thereafter corresponds to the demand for delivery of compressed air.

If the demand is increased (or decreased), there is a slight and momentary drop (or rise) in the main-tank pressure and the needle-control and needle both rise (or drop). A greater (or less) amount of air enters the auxiliary reservoir while the increased (or decreased) pressure causes the valves to shut earlier (or later) during the suction stroke. This decreases (or increases) the return of old air and increases (or decreases) the fresh supply. Opening the unloading gate lets the air out of the auxiliary tank and causes the discharge valves to stay open all the time of suction.

Fig. 1 shows the scheme rigged up with a combination "trigger," having adjustable spring and hand needle valve, as bought ready made for the ordinary volumetric regulator. Fig. 4 shows the trace of some indicator cards from a 12x10-in. belt-driven compressor.

The device can be applied to electric motor-driven compressors to maintain constant air pressure or to compress at constant load. In these cases, a magnet valve admits main-tank pressure to the auxiliary reservoir to hold open the inlet valves and this is controlled by a pressure-gage or a current-limit relay.

This regulation system is the invention of R. Wikander of the Hall Steam Pump Co., Pittsburgh.

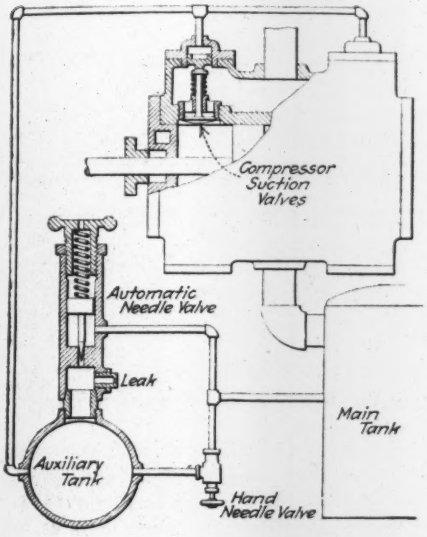



FIG. 2

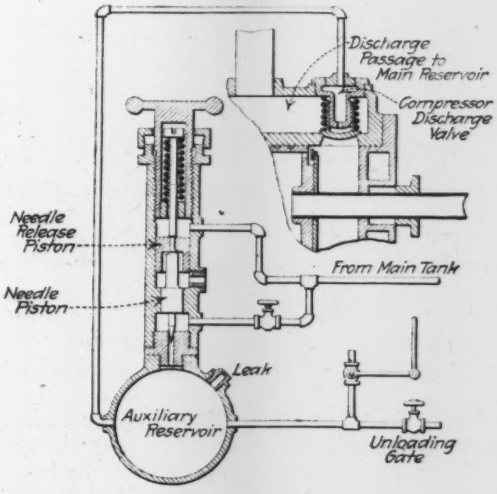



FIG. 3

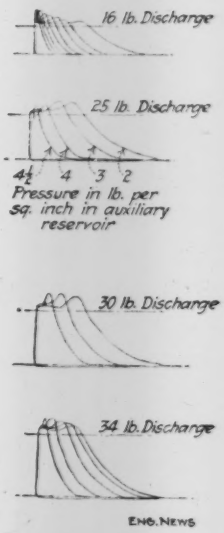



FIG. 4

**Fig. 2. Diagram Showing Volume Regulation Applied to Compressor Poppet-Suction Valves. Fig. 3. Regulation Applied to Discharge Valves of Piston-Inlet Type. Fig. 4. Traces of Indicator Diagrams from 12x10-in. Air Compressor under Varying Loads at Various Discharge Pressures.**

**The Last Horse-Operated Railway in England**—Saturday, Apr. 4, saw the end of what is believed to be the only passenger train service in the country maintained by horse traction—that on the North British Ry., between Drumburgh Junction, a few miles west of Carlisle, and Port Carlisle, a seaport on the Solvay Firth, formerly of considerable importance and connected at one time by canal with Carlisle. On the following Monday a new locomotive-drawn train service superseded the horse-drawn trains, which have run daily since 1856. Engines were used on this line between the years 1854 and 1856, but on Aug. 28, of the latter year horses were first used. ["The Engineer," Apr. 17, 1914.]

# Detroit-Superior Bridge, Cleveland, Ohio

A viaduct of exceptional size and rather peculiar design is now under construction across the Cuyahoga River Valley at Cleveland, Ohio, connecting Superior Ave. on the east with Detroit Ave. on the west. Cuyahoga River is a small stream averaging about 150 ft. in width, but the valley through which the river winds is 3000 to 5000 ft. in width, and approximately a hundred feet lower in level than the city grade on either side. There is at present crossing the valley from Superior Ave. west an old iron viaduct, built in 1876, with a swing draw at the river. It reaches Detroit Ave. about 600 ft. downstream, that is, north of the new bridge, and there is a reverse curve in the approach in reaching the line of Detroit Ave. The new viaduct will be built on a straight line connecting Superior Ave. to Detroit Ave., and at an elevation allowing 96- to 99-ft. clearance for navigation in the river. Its construction will not interfere with the use of the old bridge.

The new Detroit-Superior Bridge is a series of reinforced-concrete and steel arches 2880 ft. in length, and provided with two decks, the upper a roadway and sidewalks for highway traffic and the lower for street-railway use. The upper deck will comprise a 44-ft. 9-in. roadway with two 12-ft. sidewalks, and the lower deck will carry six lines of street-railway tracks. The main novel features of the design are the approaches on either side, the double-deck design of the concrete arches, and the very large steel arch of 591-ft. span across the river.

Foundation work has been in progress for some time on the various piers, and is now being prosecuted vigorously. The steelwork on the main arch is being fabricated, and work has just started on the construction of the approaches and on some of the superstructure.

The total cost of the bridge is upwards of $2,500,000, which is borne by Cuyahoga County.

## Substructure

The piers and abutments are of three different types. The west abutment and Piers 5 to 12, and the east abutment, are all of solid base, founded on concrete piles. Above the ground level, they divide into four pilasters, joined by transverse arches, each pilaster under the corresponding arch. Piers 1 and 2 reach down to a blue clay footing, which, it is anticipated, will be of sufficient bearing at elevation —40. They have a solid base with a cellular superstructure all underground, and carry, from the ground surface up, the pilasters in line with the arches, as in the other piers. They are being sunk as reinforced-concrete cribs, which will be put under air if water is encountered. The cellular structure of the entire pier forms the crib or caisson. One-half of the crib for Pier 1 has been sunk to the required elevation without the use of air. After getting a footing in the clay, it was practically free from water and required 450 tons of pig iron to force it down.

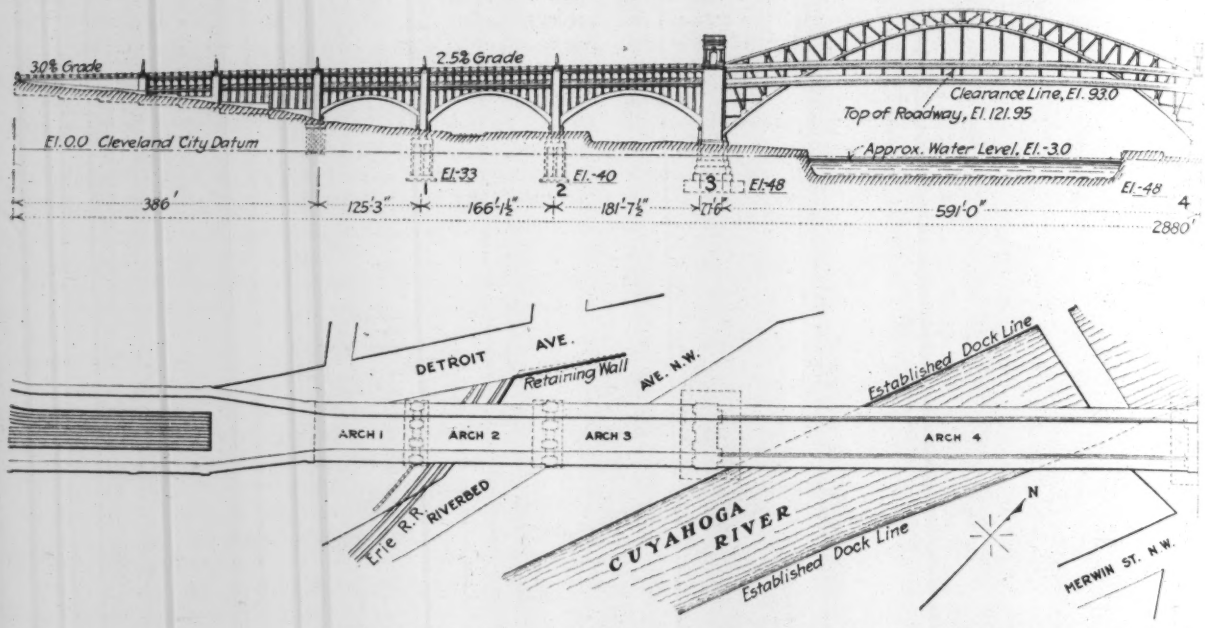



FIG. 1. GENERAL ELEVATION AND PLAN OF THE DETROIT-SUPERIOR HIGH-

The piers (Nos. 3 and 4) for the main arches are of solid construction, reaching down to Elev. —48, where a blue clay is reached. The maximum pressure on this clay is 7 tons per sq.ft. The specifications for these piers were as follows:

> **A reinforced-concrete caisson is to be constructed and sunk to the required depth, and then filled with concrete. The adoption of this plan will not be insisted upon, provided any alternate plan submitted by the contractor be approved by the engineer.**

The succeeding clause from the specifications seems to indicate that some sort of a caisson construction would be required, but in the construction of Pier 4 the foundation work was carried on in the open air, with an excavation made inside of a coffer-dam, which extended out into the river. This coffer-dam was an earth-filled wall between rows of steel sheet piling arranged as cells, after the fashion of the Black Rock harbor coffer-dam at Buffalo. The lower 16 ft. of the pier was deposited as a seal under water and after this had set the dam was

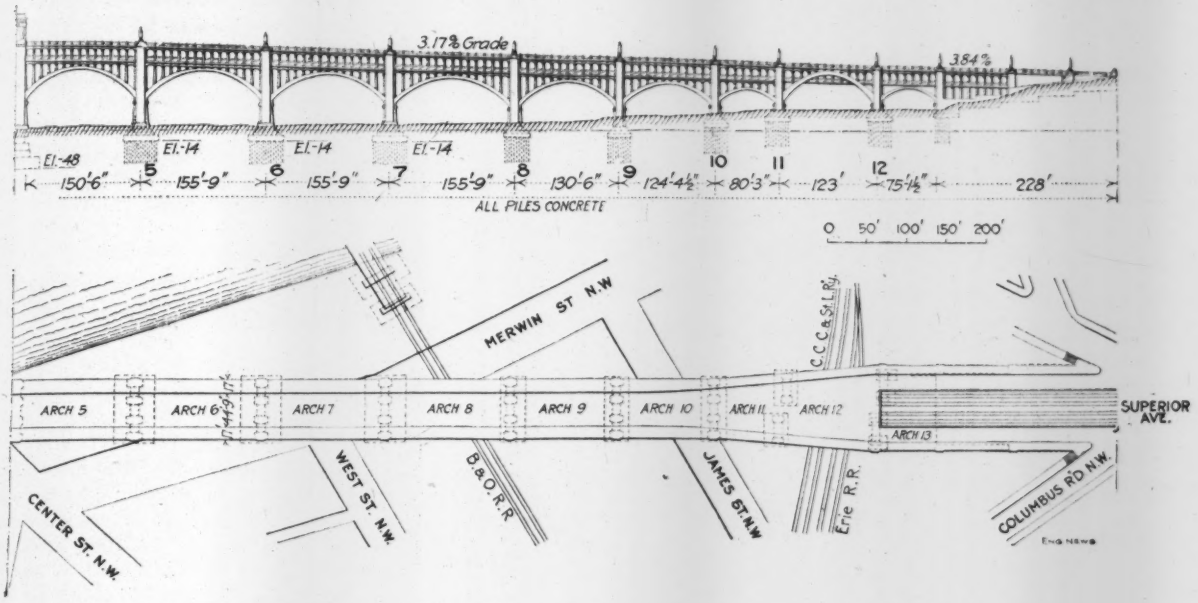
pumped out and the rest of the pier placed in the open. Considerable difficulty was experienced in keeping water out, but the pier has been brought to the top of the substructure level. Pier 3 is just about to be started, and will be put down in substantially the same manner as Pier 4.

All of the other piers are of solid construction up to the arch and are founded on closely spaced precast concrete piles driven to refusal.

The present condition of work on the piers is as follows: Piers 1 to 2, caisson construction now under way; Pier 3, just starting excavation; Pier 4, complete; Pier 5, concrete piles all driven; Pier 8, test piles down, concrete piles about to be driven; Pier 9, complete.

### Approaches

Each approach consists of a reinforced-concrete column-and-girder construction, with the columns footing




Level Bridge across the Cuyahoga River Valley, Cleveland, Ohio

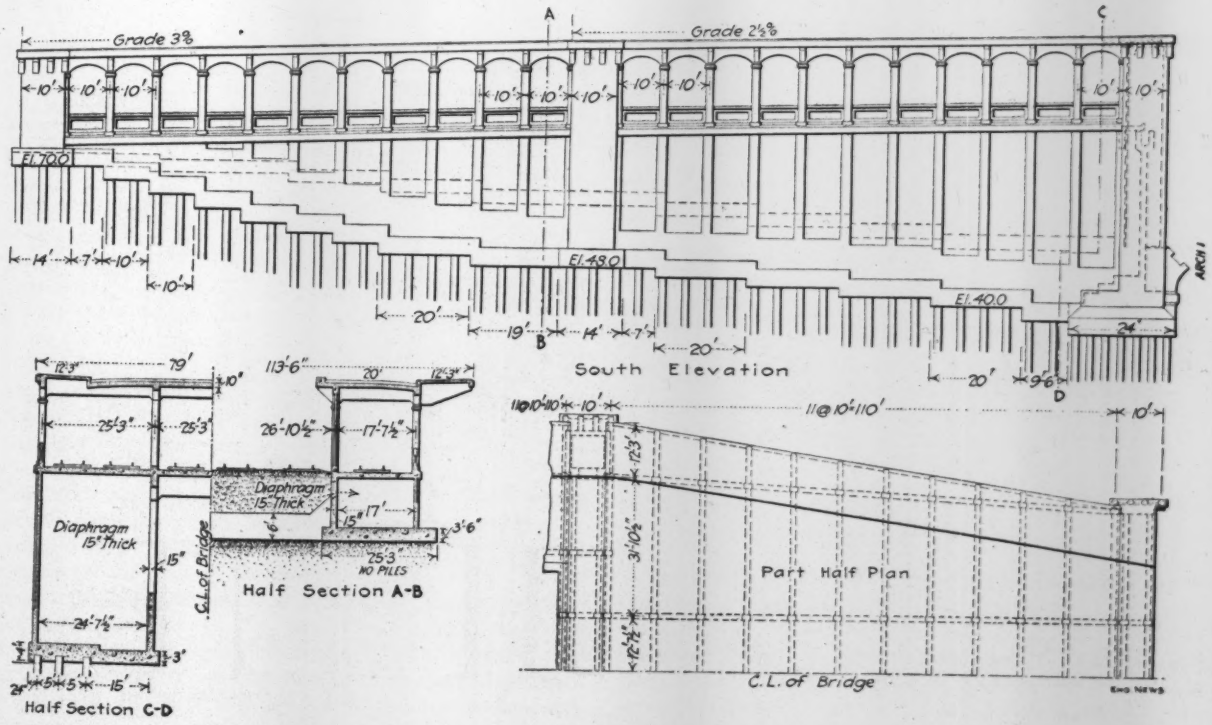



Fig. 2. Details of Approach Spans

in transverse groups of two on reinforced-concrete slabs resting on the ground, with the slabs on levels following the slope of the valley. The lower or street-railway deck slopes down from the street level to meet its established grade across the bridge proper, and at the beginning of the approach, where clearance for the street cars is necessary, the upper deck is left out between the two interior columns, as shown to the right in the section in Fig. 2. At this location, the two sets of columns are further braced by reinforced-concrete beams in the earth, and the four middle tracks are carried on an earth fill or on the natural ground. Where the approach is near the bridge proper the roadway is carried clear across the four columns, as shown to the left of the section in Fig. 2. The approach shown in Fig. 2 is on a transverse slope and the footing slabs on each side of the bridge are on different grades.

In the east approach, a short distance of the approach is filled in between retaining walls.

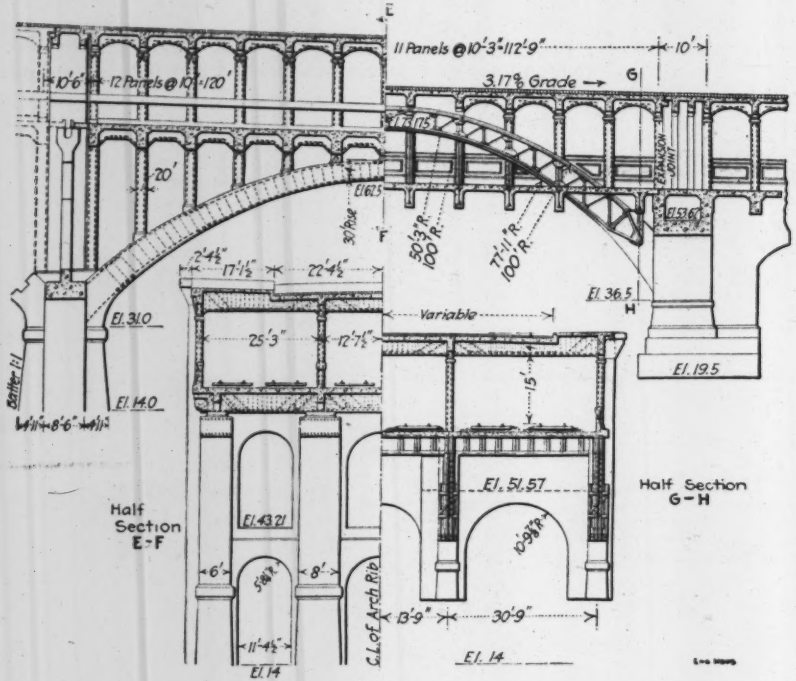



FIG. 3. DETAILS OF TYPICAL CONCRETE ARCHES

(Normally reinforced arch shown in half section at the left) (Specially reinforced arch in half section to the right)

## CONCRETE ARCHES

There are twelve concrete arches in the bridge, of spans varying from 58 ft. to 174 ft. in the clear, and all except one of the same general design, varying only in dimensions to accommodate the loads on the varying spans. The arch between Piers 11 and 12 (Arch 12) is over the Big Four Ry. track, where clearance required a design different from the typical design used in the other arches. For this arch, a high-rise curve was used, and in order to avoid centering, which would be in the way of the railway traffic, a special design, using three-hinged steel arches

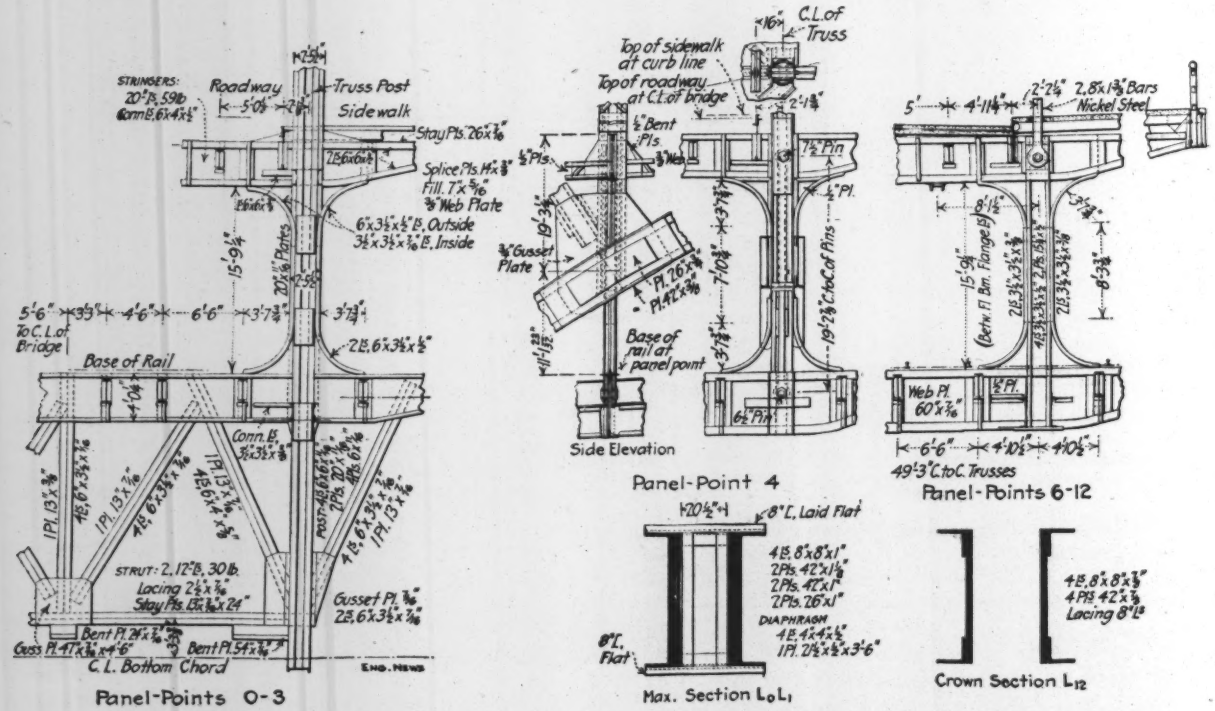



FIG. 4. SECTIONS THROUGH 591-FT. ARCH, SHOWING DIFFERENT METHODS OF SUSPENDING LOWER DECK

for both erection and reinforcement, has been adopted. The other arches are reinforced with the usual rods.

The typical design (to the left in Fig. 3) has four comparatively narrow arch ribs, spanning between solid piers, and carrying the railway deck on beam-and-slab floors resting on heavy pilasters, the lines of which pilasters are continued up as columns to carry the beam-and-slab construction of the highway floor. Longitudinal jack arches at both deck elevations are added for architectural effect and to increase the longitudinal stability of the structure. Expansion is taken care of at each pier by separating the entire superstructure above the pier. Drainage is carried down under the railway deck to each pier, where it enters a traverse drain supported by a transverse wall across the pier.

The specially reinforced Arch 12 is shown to the right in Fig. 3. The reinforcement of each rib is a framed three-hinged arch which will be erected as a cantilever from each pier, and into which will then be framed the floor-beams, bracing and lower-deck columns (also of structural steel). These members will then be incased in concrete. After this has set, the upper deck will be cast in place, as a normally reinforced-concrete structure similar to the upper deck on the rest of the bridge. Half of this arch is advanced 10 ft. beyond the other half, to provide a necessary skew for the railway tracks; this complicates the framing of the bracing and columns, but the floor-beams are continuous, the offset just equaling the panel length. (See Fig. 1).

### 591-Ft. Steel-Arch Span

The main river span is a three-hinged steel-framed arch of 591-ft. span between pins and a rise of 144 ft., with the two decks about half way up the arch, the lower deck crossing the lower chord of the arch at the third panel out from the abutment and the upper deck at the fifth panel out. Between these panel-points on either side of the arch the decks are suspended from the arch trusses.

The lower and upper chords of the arch are curves of different equations, the vertical distance between the two curves widening from 20 ft. at the crown to 91 ft. at the springing line. The arch itself is a riveted framework of the form shown in Fig. 5. Hinges are provided at the lower panel-point at the crown and at the two skew-back joints. Chord members change direction at each panel; that is, at regular spacings of 24 ft. 7½ in. The length of the long verticals near the springing line is broken by horizontal strut members. There are two arch ribs spaced 49 ft. 3 in. c. to c. and carrying the roadways of both decks between them, with the sidewalks as cantilever members.

Between panel-points 0 and 5, the upper deck has riveted connections to the arch posts and between panel-points $5_R$ and $5_L$ it is hung by eye-bars with pins running in the plane of the arches. From panel-points 0 to 3, the lower deck is riveted to the arch posts; at panel-points 4 and 5, it is hung from the lower chord of the arch by eye-bars with pins in the plane of the arch and between panel-points $6_R$ and $6_L$ it is in rigid connection with the upper deck. This variation in the method of suspension is made in order to guarantee that the wind stresses will proceed along the two decks to the lower part of the lower arch chord in a horizontal line and will not carry up into the upper part of that chord (Fig. 4).

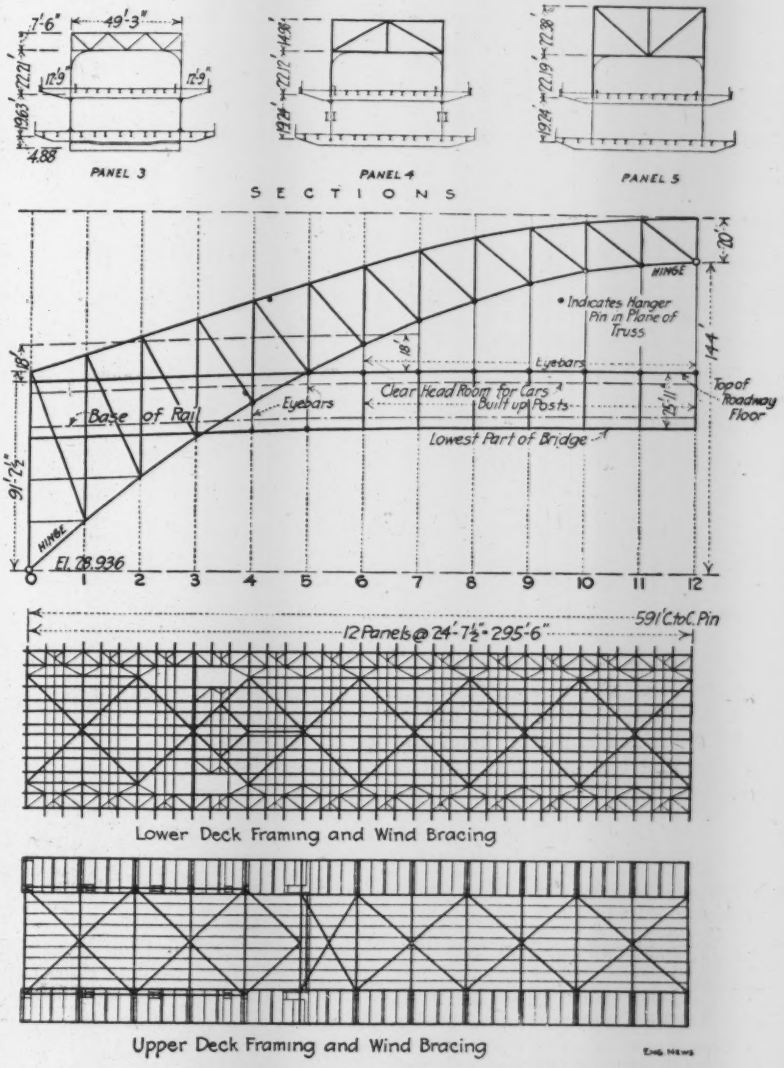



Fig. 5. 591-Ft. Steel Arch Span, Detroit-Superior Bridge, Cleveland, Ohio

The wind and sway bracing comprise transverse struts and double diagonals in the upper and lower chords of the arch rib, except at the portals which come at $U_2$ in the upper chord and between panel-points 3 and 7 in the lower chord. At these portals, bracing is provided to carry the stresses from the laterals into the chord. The lower deck is thoroughly cross-braced laterally so as to form a continuous structure between panel-points $3_L$ and

3R. The wind stresses, therefore, in this deck will carry along the deck to panel-point 3 where they enter the truss. The upper deck framing and wind bracing is not quite so complicated as that of the lower deck. Here the break in the structure occurs at panel-point 5, at which point the transverse stresses are carried up into the arch itself. Expansion joints of a special toothed type are provided at each of these breaks.

The lower-chord section is made up of four corner angles, with legs turned out, and vertical webs of 1-in. and 1⅛-in. plates. The angles are latticed with channels and the whole section tied with angle and plate transverse diaphragms about every 6 ft. The largest section $L_0 L_1$, 293 in., and the crown section $L_{11} L_{12}$, 205 in. are shown in Fig. 4. The splices in the lower chord

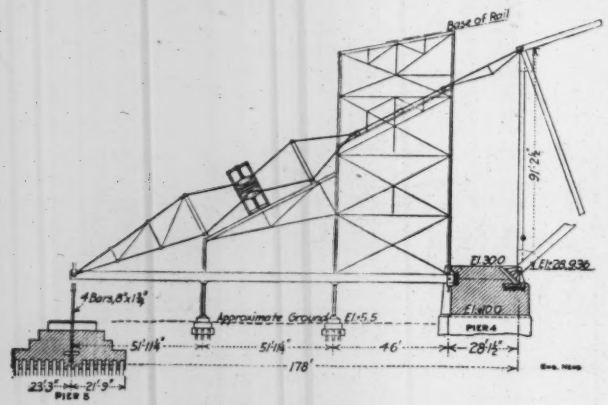



FIG. 6. TIE AND TOGGLE TO BE USED IN ERECTING THE 591-FT. STEEL ARCH

are 100% splices at $L_4$, $L_5$ and $L_6$, and are 75% to 80% splices at all other points.

The large arch is to be erected as a cantilever from each side and the crown lowered by the toggle shown on the erection diagram in Fig. 6.

Nickel steel will be used for the arch trusses, all eye-bars and pins. Carbon steel will be used for bars and angles for lacing and stay plates and for all floor-beams, stringers and bracing. Cast steel is to be used for the shoes, but the grillage under the shoes is to be of structural steel.

### CONTRACTORS

The contracts for the bridge are held by four different firms, as follows:

| | |
|---|---|
| **The Hunkin-Conkey Co., Cleveland, Ohio**<br>West abutment and approach<br>East abutment and approach<br>Pier 12<br>All superstructure except 591-ft. arch | $1,028,571 |
| **The O'Rourke Engineering Construction Co., New York City**<br>Piers 3 and 4 | 276,200 |
| **The King Bridge Co., Cleveland, Ohio**<br>Steelwork of 591-ft. arch | 571,875 |
| **The Great Lakes Dredge & Dock Co., Cleveland, Ohio**<br>Piers 1-2, 5-11<br>Setting shoes on Piers 3 and 4 | 497,687 |
| **Total contract price, leaving out railing and paving contracts not let** | $2,374,333 |

### ENGINEERS

The Superior-Detroit Bridge is being built by Cuyahoga County, Ohio. It was designed under the direction of F. R. Lander, County Engineer and A. M. Felgate, Bridge Engineer, and is being constructed under the direction of W. A. Stinchcomb and A. W. Zesiger, who now hold the offices of County and Bridge Engineer, respectively. Jas. A. Joyce is Asst. Engineer in charge of steelwork.

## Protection Against Inundation in Holland

BY WILLIAM HOEKER*

The flood-protection works of Holland are directed against both the sea and the rivers. The construction of the dikes and groins is quite familiar, but a brief statement of the applicability of the several protective methods in use may interest Amrican engineers.

The comparative area of Holland below sea level and subject to floods, is shown on the map, Fig. 1. Against the sea, nature has provided the foundation of an excellent defense in the form of sand dunes which occur along the coast. It is necessary to protect these against erosion. They are largely covered by coarse grass or reeds, and where such growth is sparse, the spaces are faced with planks. Willful damage to the dunes carries a severe penalty. Dunes exposed to a steady current are protected from scour by mattresses, placed at their feet. In more exposed sections, creosoted piles are driven fairly close together in the network of branches or fascines, and the spaces between piles filled in with stone blocks or cobbles. Ordinarily, the mattresses and sand bottom are separated by a layer of clay, to make the whole more per

FIG. 1. MAP OF HOLLAND, SHOWING RELATIVE ELEVATION ABOVE SEA

manent. The mattresses are often very large, and are made on shore and carried to their bed by a number of flat-bottom vessels; often eight vessels, four on each long side, are required to keep the mattress even. At the site, the guy ropes to all the vessels are cut simultaneously, and the mattress, loaded evenly with heavy stones, sinks to the bottom.

*24 Plaats, The Hague, Holland.

In strong currents, breakers known as "hoofden" or heads, are placed short distances apart. These are formed of several lines of piling at different elevations, so that the sand dumped upon them takes the form of a long mound. Rubble is dumped over the top. These hoofden are used also to deflect currents.

When the dune protection is insufficient, artificial earth mounds or dikes are built and faced with basalt or concrete. Concrete facing is of the two types of the well known De Muralt system, which has been described in ENGINEERING NEWS. In one instance, square slabs are laid in a framework of reinforced concrete and the seams filled with asphaltum. The slabs are further held by a sort of concrete nail placed through the tops. The concrete steps of the second type are held together by concrete stringers placed at right angles.

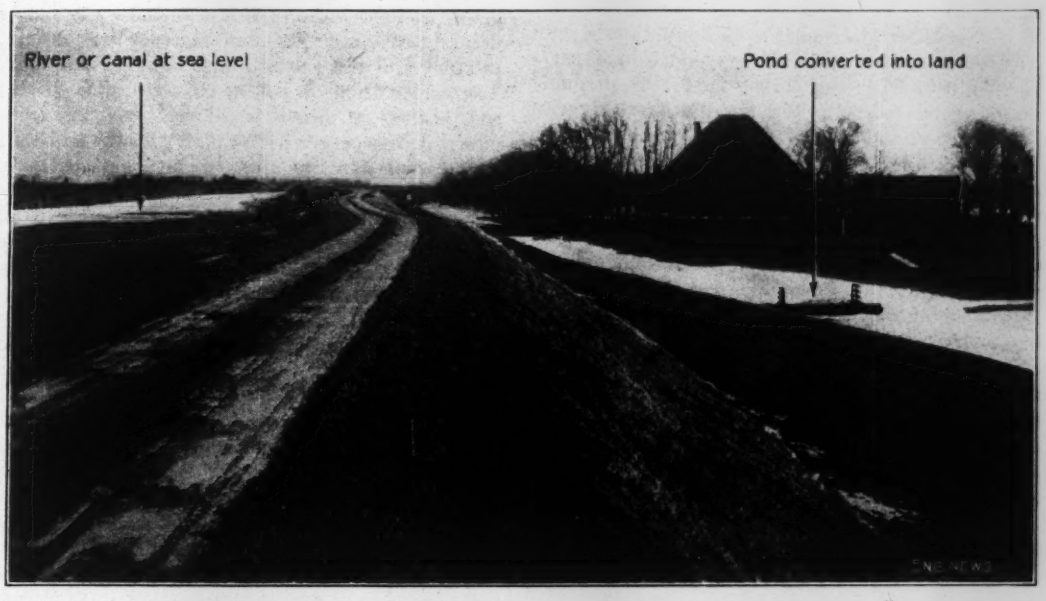



FIG. 2. A DIKE IN HOLLAND, WITH POND ON RIGHT BEING PUMPED INTO SEA LEVEL RIVER ON LEFT

On low-lying dikes, a concrete wall is sometimes built. At river and canal mouths, large stone-block jetties are built.

RIVER FLOOD PROTECTION—The three large rivers—the Rhine, Meuse and Scheld (Fig. 1)—flowing into the North Sea, are the greatest menace as regards inland floods. Large earth embankments or levees are built along the river banks. Ice jams sometimes rise many feet above the levees, while at other times the current is extremely swift. At dangerous points, repair tools and materials are provided, and a permanent watchman with a signal cannon, is stationed. These levees are faced with clay, fascines and rubble.

Considerable land is reclaimed by canal drainage. A lake or pond is surrounded by an embankment, and a canal built from it, connecting with a river or trunk canal. The water is then pumped out of the lake. Steam or electric mills are replacing the picturesque wind mills. The pumping is continuous. The bed of such a pond is shown at the right of Fig. 2. At the left is a stream at sea level, into which is constantly being pumped the water which accumulates at the right of the road.

**Timbering Fires in Iron Mines** in the Lake Superior region is the subject of Technical Paper No. 79, issued by the Bureau of Mines, Washington, D. C. If the ore, the walls of the orebody, or both, are of such character that the ground will not stand without timbers, some form of top slicing, sub-level slicing and caving is usually adopted. These methods with their many variations necessitate the use of a vast amount of timber, practically all of which remains in the mine. As mining progresses the timber crushes and forms a mass, which serves as a barrier between the mine workings and the waste rock. The mass, which includes some waste rock, constantly increases in thickness as mining goes downward, so that in course of time it may become several hundred feet thick. Loose shafts are lined entirely with timber. Some have steel sets with timber lagging, and others are of steel and concrete construction throughout.

Obviously the steel and concrete shafts are safest. If timber is used, the dry shaft is, of course, the most dangerous; although the wet shaft is not immune from fire. There are certain fire-resisting materials, such as zinc chloride, which render shaft timbers less inflammable. Dry shafts should be sprinkled with water at sufficient intervals to keep the timber at least damp. Sprinkling may be accomplished by various means. If a separate water line from the surface is provided the pipes may be tapped every 100 ft. and a valve and a 50-ft. length of hose supplied.

In a certain mine on the Gogebic range the water column in the shaft is tapped every 50 ft. Owing to the high-water pressure, a special pressure-reducing valve is attached. Connected to this valve are four jets pointing in different directions, so that all parts of the shaft may be reached by the water. The handle of each valve is securely attached to a ⅜-in. steel cable, and this in turn is connected with a lever at the shaft collar. The lever may be operated by one man and all the valves opened simultaneously. The shaft has a dip of 75° and is about 1100 ft. deep.

The sealing of shafts or mine workings is usually a last resort. In sealing the shaft collar the common method is to use planking well covered with manure or damp earth. If the fire has reached the surface, steel or iron rails may be thrown across the collar and steel plates pushed over the rails. When thus covered, loam, clay or fine sand can be shoveled over the top and puddled.

For bulkheads underground 2x12-in. planks covered with paper, the cracks being stuffed with rags, have been used. In one case a double barrier of this kind, barriers spaced 3 ft. apart, the intervening space filled with earth, was used. The safest device and the most dependable is the metal door, fitted into a masonry framework.

Copies of this paper can be obtained from the United States Bureau of Mines, at Washington, D. C.

# Explosive Gases in Sewers

By George J. White*

Explosions of gases in sewers, while not of very frequent occurrence, constitute a serious danger to both life and property in cities. A discussion of the various gases which may ordinarily collect in sewerage systems will serve as an introduction to this paper.

## Gases Found in Sewers

Air—Air consists of approximately 20.96 parts of oxygen, 79.0 nitrogen, 0.04 of carbon dioxide, and other impurities, by volume. It is colorless and odorless. It has a specific gravity of 1, and forms a basis to which the specific gravities of other gases are referred. It is not explosive in itself, but furnishes the oxygen necessary for the explosion of other gases, which by themselves may be nonexplosive.

Sewer Gas—Sewer gas consists of approximately 90 parts of nitrogen, 2 to 4 parts of oxygen, 1 to 3 parts carbon dioxide, 3 to 5 parts of carbon monoxide, methane and other gases, by volume. The specific gravity varies with its composition and is approximately 1, or the same as air. It has an odor due to the organic decomposition constantly going on in the sewage with which it is in contact. It is not poisonous in the true sense of the word, but due to its high percentage of nitrogen and low percentage of oxygen, it will not furnish a sufficient amount of oxygen to support respiration, and hence a person is slowly smothered in an atmosphere of this gas. It is nonexplosive in itself and, due to its high nitrogen and low oxygen content, would undoubtedly prevent the explosion of otherwise explosive gas when mixed with it, unless some other gas such as air were added to furnish the necessary oxygen for the combustion.

Coal Gas—Coal gas is made by the destructive distillation of high-volatile coal in clay retorts. Its composition varies with the kind of coal used and the details of manufacture. It consists of approximately 3 parts of illuminants (ethylene, etc., of the $C_nH_{2n}$ group), 35 to 40 parts of marsh gas, 45 to 50 parts hydrogen, 4 to 8 parts carbon monoxide, 0 to 2 parts oxygen, 1 to 2 parts carbon dioxide and 3 to 5 parts nitrogen, by volume. It is colorless, but has a very strong penetrating odor, so that a small percentage of coal gas mixed with air may be readily detected by the sense of smell. In itself, it is not explosive, and must be mixed with air or some other gas which will furnish the necessary oxygen for combustion. A cubic foot of ordinary coal gas requires 1.21 cu.ft. of oxygen, more or less, due to the variations in the constituents of the gas, for complete combustion. If we allow 20% of oxygen in the air, then for complete combustion $1.21 \times 5 = 6.05$ cu.ft. of air is necessary to furnish the oxygen for the combustion of 1 cu.ft. of gas. An explosion will take place with mixtures of from 4 to 12 parts of air with one part of coal gas, the intensity of the explosion varying with the mixture. The specific gravity of coal gas varies with its composition from 0.50 to 0.60, or it is about one-half times as heavy as air.

Water Gas—Water gas is made by passing steam through a bed of incandescent carbon. Water gas thus made would have a comparatively low heating value and relatively small candle power. Therefore, it is enriched by spraying volatile oils on pure water gas while passing through towers filled with checker-work brick, which are heated to incandescence. The composition of water gas varies with the details of manufacture. Water gas is composed of approximately 25% carbon monoxide, 10% illuminants, 30% of hydrogen, 1% oxygen, 3% carbon dioxide, 25% methane and 6% nitrogen, by volume. It is nonexplosive in itself and must be mixed with air or some other gas which will furnish the oxygen necessary for combustion. It has approximately the same explosion range as coal gas. It is extremely poisonous, due to its high carbon-monoxide content. It has a penetrating odor, even more noticeable than that of coal gas. The specific gravity of water gas varies from 0.45 to 0.55 with its composition.

Coke-Oven or Solvay Gas—Coke-oven or Solvay gas, like coal gas, is made by the destructive distillation of coal in ovens. In coal-gas manufacture, the gas is the main product, while coke is a secondary or residual product. In coke-oven gas manufacture, the coke is the main product and the gas is a secondary or residual product. The composition of Solvay gas is similar to that of coal gas. Like coal gas, it is colorless and has a penetrating odor. Like coal gas, it is nonexplosive in itself, but becomes explosive when mixed with various quantities of air. The range and the intensity of the explosion are approximately the same as those of coal gas.

Illuminating Gas or City Gas—Illuminating gas or city gas as generally distributed, may be coal gas, water gas, Solvay gas, or a mixture of any two or all of these gases. It is colorless and has a strong penetrating odor. Gas fitters can detect a leak in a gas fixture, by the sense of smell, that will not light. It has ordinarily a specific gravity of 0.50 to 0.60 or about one-half that of air. It is nonexplosive in itself, and will explode only when mixed with 4 to 12 volumes of air. City gas stored in a gas holder would not explode if the holder were struck with lightning. If the tank was ruptured sufficiently to let any large amount of gas escape, there would simply be a flash similar to that following the throwing of a lighted match into an open barrel of gunpowder. I have seen workmen mark leaks on a gas holder by igniting the gas issuing from the holes.

Gasoline—Gasoline of the American trade varies somewhat in its specific gravity from 0.70 to 0.74 as measured by the Baumé scale. 0.70 is a light grade, and 0.74 is termed stove gasoline from its general use for heating. The analysis of the 0.71 gravity gives carbon 838; hydrogen, 155; impurities, 7 in 1000 parts, with a heating value of about 18,000 B.t.u. per lb. The variation of the gravity of gasoline is due to the variation in the percentage of hydrogen. The vapor of gasoline is equal to 160 cu.ft. per gal., or about 1200 times its liquid bulk. A saturated air gas of equal parts air and vapor equals 320 cu.ft. per gal. of liquid. It is nonexplosive in itself, and when mixed with air is used as an explosive power in gasoline and automobile engines. The boiling point of gasoline such as is used for explosive engines, ranges from 150° to 180° F., and the flashing point of the liquid ranges from 10° F., with complete combustion of the vapor. The vapor of gasoline from 1 lb. of the liquid requires 189 cu.ft. of air and as 1 lb. is equal to 26 cu.ft. of vapor, $^{189}/_{26} = 7.3$, so that one part of gasoline vapor with 7.3 parts air may be used to produce a perfect combustion. Fewer parts of air will leave a residuum of unconsumed vapor, while an excess of air will lessen the intensity of the explosion, and if the ex-

*Gas Inspector and Analyst, Department of Public Works, Detroit, Mich.

cess is sufficient will prevent the explosion. Gasoline vapor has, when mixed with air, an explosion range from 2 parts air to 1 part of gasoline vapor up to 19 parts air to 1 part gasoline vapor, the intensity of the explosion varying with the mixture. The specific gravity of gasoline vapor is from 1½ to 2½ times that of air. It is colorless and has a penetrating odor.

### Sources of Gas Vapors in Sewers

Our cities are covered with a network of pipes used in the distribution of illuminating gas. Breaks in these gas mains very often lead to the escape of this gas into the sewer systems. Due to the comparative depth of trunk sewers and gas mains, it is not likely that any great amount of illuminating gas gets into the trunk sewers themselves. We may expect and do find it in lateral sewers, telephone and electric-light conduits, where comparatively small amounts would be necessary to furnish an explosive mixture. Where telephone and electric-light conconduits have untrapped connections to the main sewers, there will be a tendency for any illuminating gas present in the main sewer to escape into these conduits. Since it is only one-half times as heavy as air, it is more likely that any illuminating gas getting into a main sewer would tend to work its way out through the lateral sewers which feed into it, or through the openings in the manholes in the main sewer itself. The odor of illuminating gas escaping from a sewer would be decidedly noticeable long before sufficient gas to form an explosive mixture became present.

In the summer time, the temperature of the floors of garages and pavements of a city are at or above 50° F., the vaporizing point of gasoline, so that any gasoline spilled on the pavements or on floors of garages would evaporate and mix with large volumes of air, in which condition it is not explosive, without ever reaching the sewers.

In the winter the reverse is true. The temperature of the pavements and the floors of garages is below 50° F., so that any gasoline spilled is very likely to reach the sewers. The temperature of the water in the sewers varies from 40 to 60° F., so that it is quite likely practically all of the gasoline which reaches the sewer is vaporized there. Since the specific gravity of the gasoline vapors is 1½ to 2½ times that of air, these vapors will follow the surface of the water and will not tend to escape from the trunk sewers through the lateral sewers and the manholes. During the winter, most of the pavements are covered with ice and snow. Any gasoline spilled on the pavements is frozen and becomes mixed with ice and snow so that when we get warm rainy days, the snow melts, thus releasing the gasoline. We may expect to find an unusual amount of gasoline in our sewer system following a heavy winter rain which at the same time forces large quantities of water and fresh air into our sewers. We may then expect to find the composition of our sewer gas to vary and contain unusually large amounts of oxygen which are necessary for the explosion. That is, the average sewer gas when mixed with any gas alone in any proportion could not explode, due to the high percentage of nitrogen and low percentage of oxygen.

We must have oxygen as well as gas or gasoline vapor present in a sewer to form an explosive mixture. To furnish oxygen, we must have fresh air, as air which has stood any length of time in contact with sewage is robbed of its oxygen. So we must expect these explosions to occur after a period of rainy weather. Dry-cleaning establishments use large amounts of gasoline in their cleaning processes, using this gasoline over and over until it becomes so dirty that it cannot be used any longer. The easiest way to get rid of it is to put it in the sewer. Analysis of sewage taken from some of the sewers has shown as high as 1 gal. of gasoline per 1000 gal. of sewage. This is an extremely high content. If this were general, the amount of gasoline vapors in many sewers would be explosive at all times, if sufficient oxygen were present to allow the explosion.

### Means of Ignition

The streets of our cities are covered with a network of underground electric systems, such as telephone, electric light, street railway and power cables. Evidence of leakages in these underground electric systems is always present in the corrosion of water and gas mains by electrolysis. An electric spark due to this leakage would cause an explosion of any gas mixture which was explosive. Sometimes the side of a manhole cover is cut off to make room for a street car. A spark from the street-car wheel as it goes by the manhole may ignite the mixture. A fire engine passing over the manhole may drop a spark which will explode an explosive mixture. The flame from a lantern taken into a sewer by careless workmen may cause an explosion. A lighted match dropped carelessly on a manhole may cause an explosion. In fact, there are countless ways in which an explosive mixture may be ignited.

### The Effect of Curves in Sewers

Curves in the trunk sewers offer a resistance to the free flow of gases through the sewers, causing them to bank up at these points. Changes in cross-sectional area in the sewer have the same effect. At these points, we may expect to find explosive mixtures in our sewers if they are present anywhere. If a means of ignition is furnished, the explosion occurs at these points where the explosive mixture is present. The primary explosion forces the gases through the sewers, putting them under pressure, in which condition a gas which under atmospheric pressure is not explosive, may become explosive. The ignition wave follows the pressure wave and as a result there is a continuous series of explosions throughout the sewer, until a point is reached where the gases present are no longer explosive.

### How to Prevent Explosions

It is a case of either elimination of the explosive gases or ventilation of the sewers. It is impossible to absolutely prevent leakages from illuminating gas mains getting into the sewers. It is impossible to keep sewers absolutely free from gasoline vapors. It is impossible to always economically eliminate curves in the sewers.

It is then more a question of ventilation. The openings in manhole covers are designed to do this. If they are allowed to become clogged up with dirt and snow, they certainly do not fulfill their mission. Manholes are usually at least one block apart. If there are sharp curves or change of cross-sectional area in a sewer between two manholes, it is most likely that explosive mixtures will be found. Then that curve must be ventilated. This may be done by means of a stack built inside of the curb line with a conduit running to the top of the sewer. If the natural draft is not sufficient to ventilate the

sewer at the danger point, then it may be necessary to resort to artificial draft through this stack. If these danger points are not equipped with stacks, removing the manhole covers for a few hours during the rainy days of winter will no doubt provide sufficient ventilation to prevent explosions.

There need be no fear of a serious explosion in a straight-barreled sewer at any time. There need be no fear of a serious explosion in any sewer during dry weather. Rainy days during the winter are the danger periods and if care is taken to provide sufficient ventilation at the danger points during these periods, the writer believes that sewer explosions may be eliminated.

## Double-Deck Freight Houses*

By E. H. Lee†

Terminal facilities are rapidly becoming the particular element of the fixed investment for railways which most need enlargement, and it is important to determine the best means of increasing the capacity of large city freight houses, with due regard to economy in both investment and operation.

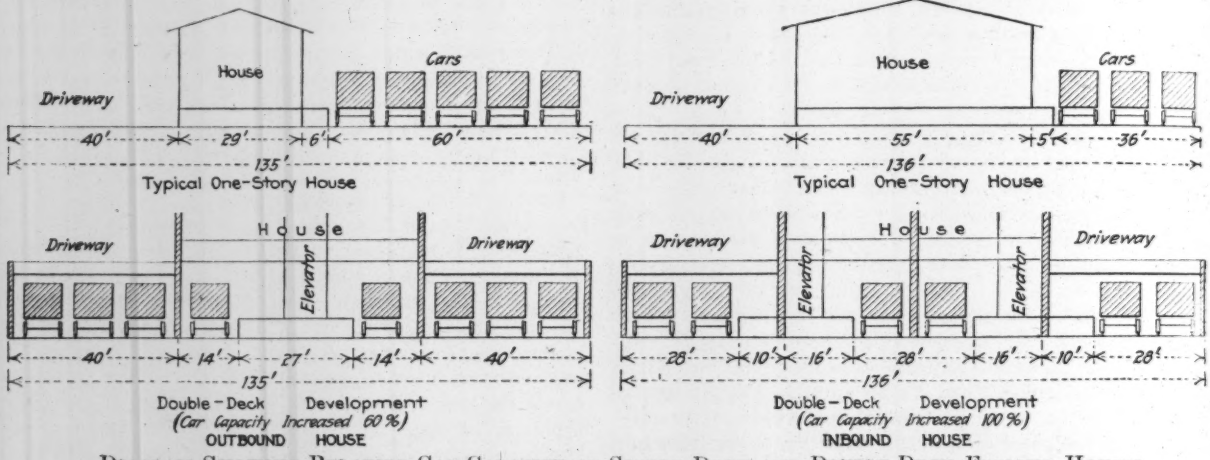



Diagram Showing Relative Car Capacity of Single-Deck and Double-Deck Freight Houses on the Same Site

The package or l.c.l. (less than carload) freight business is an important part of city freight traffic, and in Chicago amounts to 10% of the total tonnage and 25% of the total cars handled. In relation to the entire freight traffic of the country, these proportions are but 4.3% and 12.7%, respectively. This class of traffic is of greater importance than appears from its proportion to the total business, because it is high-class freight, carried at $40 to $50 per car, or $6 to $8 per ton.

Although the gross revenues thus derived are large, the cost of handling this class of business is very high, as terminal fixed charges and operating expenses, including charges absorbed, sometimes amount to $2 or more per ton ($1.50 fixed charges, 50c. operation). Such costs at each end of the shipment consume a large part of the rate received. The l.c.l. business is growing at the rate of about 5% a year. It therefore doubles every 15 years. This growth, although it increases gross earnings, in many cases causes great congestion and higher operating costs.

### Freight-House Facilities

The need of centrally located and accessible freight houses, for both railways and shippers, is apparent. The cost per ton-mile of teaming is many times the ton-mile freight rate; for example, in the downtown districts of Chicago it is estimated to be 50c., exclusive of the cost of loading and unloading.

The usual freight-house layout is simple: a long, low, narrow building with a driveway on one side, and from one to eight (or more) tracks on the other. Inbound houses are wider and served by fewer tracks than outbound houses. A public street is often used for the driveway, but the street is usually widened 10 ft. to 30 ft. so as to better accommodate standing teams. For small houses, and where land is cheap, this is undoubtedly the most economical arrangement, but where land is worth from $5 to $20 (or more) per sq.ft., and where a house must be 800, 1200 or even 1800 ft. long to secure the necessary car capacity, the investment becomes increasingly heavy and the cost of operation high. Furthermore, when street and railway grades are separated, the inclines between driveways and streets consume much valuable space and impose an added burden on teams and shippers.

The high interest charges on downtown freight terminals may be illustrated by an inbound house in Chicago. It is 1000 ft. long and 50 ft. wide, with a 40-ft. driveway on one side and two tracks on the other, occupying a total area of 1000 ft. by 120 ft., or 120,000 sq.ft. The land is valued at about $16 per sq.ft. The total land investment then is $1,920,000, exclusive of area occupied by leads. At 5%, the interest charges are $96,000 per annum. The business handled is 50 cars per day or 15,000 cars per annum. The interest charges per car, then, are $6.40, or at six tons per car, $1.07 per ton. Adding to this the operating cost of 48c. a ton, the total cost is $1.55. This is an actual example, and there are some 30 freight houses in Chicago alone whose charges may be considered somewhat similar.

The amount of trucking varies directly with the length

*Abstract of a paper in bulletin No. 165 (March, 1914) of the American Railway Engineering Association, Chicago, Ill.

†Chief Engineer, Chicago & Western Indiana R.R., Chicago.

of the house. The average trucking distance is 53% of the length of the house, and the operating cost increases 1c. per ton for every 35-ft. increase in length. It is evident that any increase in the length of a house, although giving a greater car capacity, increases the cost of handling, not only of the additional business obtained, but of the entire business.

Any freight house of the usual one-story type which handles adequately the business offered, has four kinds of facilities: (1) car-standing capacity, with suitable lead or approach tracks; (2) platform area; (3) platform frontage for teams; (4) team driveway. In outbound houses the platform area varies from 213 to 570 sq.ft. per car standing room, the average being 247 sq.ft.; the team frontage per car varies from 4.6 to 19.2 ft., the average being 10.2 ft. The width of driveways varies from the street only to a 35-ft. driveway.

The car-standing capacity first feels the pinch of congestion. This can be increased in different ways: (1) by the addition of more tracks against the house, although this decreases the team frontage per car, increases the cost of spotting cars and (in inbound houses) causes confusion between gangs of men; (2) by adding to the length of the house and its present tracks, which also increases the cost of operation; (3) by handling the transfer business at outlying points, thus relieving the terminals of all except strictly city business; (4) by a more rapid handling of the business in the house; (5) by the use of trap cars; or (6) by "double-decking," that is, by placing cars on each side of the house on one level, and driveways on each side on another. Either of the first two methods increases the investment in land and also (slightly) in improvements.

### Freight Houses and Warehouses

Building a double-deck instead of a single-deck freight house, increases the car-standing capacity of a given piece of ground by 60 to 133%.

As land increases in value it becomes more economical to use less money for ground and more for improvements; that is, an increase in the money spent in improvements accomplishes a proportionately greater decrease in the amount of money necessary for land. Double-decking does this, and it also eliminates grade crossings, with the consequent delays to teams and the danger of accidents due to switching. Moreover, when streets are carried over tracks on viaducts or beneath them in subways, double-decking avoids the need for long, expensive inclines, between driveways and streets, which occupy space and tend to make a freight house inaccessible.

As the freight must be handled between two levels, the cost of operation in some items is increased. But because the freight house is shorter and more compact, the operating cost in other items, especially the trucking, is reduced, often more than enough to offset the increase.

There are several double-deck freight houses now in use, and although built mainly to meet local conditions rather than to decrease charges and expenses, yet some decrease in interest charges and operating costs has resulted.

A still further decrease in fixed charges may be obtained by building storage or warehouse floors above the freight house. This can be done in one- or two-level houses. It decreases fixed charges, and gives the tenants excellent shipping facilities, but there is danger that the requirements of tenants may be such as to seriously diminish the ultimate capacity of the freight house, although possibly leases can be drawn which will eliminate this objection. Where the overhead space can be used for light manufacturing or office purposes, the above objection may not hold true.

### Handling Freight

Freight can be transferred between two levels by several means: (1) telfers; (2) gravity chutes; (3) mechanical conveyors (belts or platforms); (4) elevators. Telfers are useful in special cases, but are not suited to ordinary freight-house use. Chutes and conveyors are open to objection on account of the extra handling (to and from the chute or conveyor), inflexibility, damage to freight, and congestion.

The use of elevators commends itself as generally suitable for use in freight houses. It lends itself particularly well to the handling of l.c.l. freight as it involves practically no rehandling, and because either a two-wheel truck or a four-wheel truck can be put through the elevator equally well. The latter is the better vehicle, as it has a greater carrying capacity. A trucker can handle 800 or 1000 lb. on a four-wheel truck as easily as 200 or 300 lb. on a two-wheel truck, for the former does not tax his strength in lifting and supporting part of the load, and allows him to put all of his effort into pushing the truck. Elevators are flexible (need only be run when necessary), safe, reliable, can be designed so as to have a large capacity, and are cheap in operation.

The elevator should be wide enough to carry a loaded four-wheel truck and long enough to hold four or five of them in a row. To fill these conditions the dimensions would be about 8x20 ft. Elevators are built with speeds of 50 ft. and 100 ft. per minute. Either speed is suitable, for the limiting point is not the time between floors, but the time at each floor, and the elevator should be designed to permit rapid loading and unloading. Observations in houses of this kind indicate that the elevator can be unloaded and reloaded in about 60 sec. The capacity of the elevator should be from 10 to 60 tons per hour (minimum and maximum). A fair average in existing houses is 20 tons per elevator per hour, capable of being speeded up to 60 tons in rush periods.

The cost of operation of elevators is low, averaging one to two cents per ton for power, and a little less for labor (attendant). In addition to the actual cost of operation, however, there is some extra trucking, as there would be some lost motion. It is estimated that these costs (in a well-designed house) will be as follows: power and maintenance, 1½c. per ton; labor (elevator man), 1c.; delay to truckers, 1½c.; total, 4c. per ton.

### Conclusions

The l.c.l. freight business of large cities is growing rapidly. The need for enlargement of facilities is becoming more pressing. The investment required is constantly becoming heavier. The obstacles to one-level expansion are becoming more severe. The removal of transfer freight to outlying points provides only temporary relief from congestion. More rapid handling of the business in many cases requires too radical a change in local shipping customs. Mechanical handling, even if economical, has but slight effect on capacity. Double-decking is a logical method of improvement. It decreases both the investment per car and the operating expense, and also adapts itself to grade separation.

# Records of Heavy Rainfall and Runoff in Porto Rico

By L. V. Branch*

The information contained in this article was compiled by the writer from the records taken under the direction of J. W. Beardsley, Chief Engineer, by F. A. Murray, Hydrographer of the Porto Rico Irrigation Service. This Service is a government organization created by insular law in 1908 for the purpose of constructing and operating an irrigation system on the south coast of the island. This region has a large area of sugar-cane land but is deficient in rainfall for the best results from this crop.

As the low-water flow of all the streams of the district had already been diverted and used on the lands, the requirements of the Irrigation Service were to store and use the flood waters of these streams. In addition, at two places, the main divide of the island has been pierced by tunnels 2770 and 3000 ft. long and waters diverted through these from the north slope.

The main divide of the island, running east and west, is located in general parallel to and about 10 miles distant from the south coast and approximately twice this distance from the north coast. This main divide runs from 2000 to 3500 ft. above sea level. The mountain slopes are very steep and the topography broken.

When the irrigation studies were started in 1907, there were few records of low-water flow of the streams and no records of flood flow. For the past seven years, the irrigation service has maintained gaging stations and secured runoff records on all the streams in which it was interested. Low-water stream measurements were made with current meters, while flood flows have been determined by slope gages placed on carefully surveyed sections of the river. These studies have shown some very interesting results especially as regards the maximum runoff as shown in the accompanying table.

## Toro Negro River Flood of Oct. 27, 1911

As will be noted by the difference between the daily mean flow and the maximum flood peak, these flood peaks are of very short duration. They come only at a time of a heavy rainfall, occurring when the ground is thoroughly saturated by previous rains. The Toro Negro River flood of Oct. 27, 1911, is a typical flood.

The catchment basin of the Toro Negro River above the gaging station is nearly circular, the maximum length of the basin being about 2 miles, and on the north side of the divide. The gaging station and rain gage are located at elevation 2200, while the main divide averages between 3000 and 3500 ft. above sea level.

During the morning of Oct. 27, the river flow had averaged 20 sec.-ft. Rains began at 1 p.m. and ended at 4 p.m. During these 3 hours the total rainfall was 4.25 in., of which the larger part fell during the first half hour.

The river commenced to rise almost as soon as the rain started; the flood wave of 10,220 sec.-ft. passing the rating station at 1:45 p.m. or only 45 minutes after the rain started. The flood fell nearly as fast as it rose; at 2 p.m., being 3000 cu.ft. per sec., and at 6 p.m., 400 cu. ft. per sec.

The maximum rate of runoff per square mile was 3069 cu.ft. per sec. The relation of runoff to rainfall was as follows:

Precipitation 4.25 in. on 3.33 square miles = 755 acre-feet.

Runoff during flood, 704 acre-ft. less 32 acre-ft. for normal flow = 672 acre-ft. flood flow.

Percentage runoff = $\frac{672}{755}$ = 89%.

## Jacaguas River Flood of Oct. 8, 1912

During the night of Oct. 7-8, 1912, the south coast of Porto Rico experienced an exceptional rain. The floods resulting from this rain are noted for each of the streams given in the above table. The rainfall between sunset and sunrise averaged, over all the area drained by these streams, from 7 to 13 in. The maximum figure was recorded at the Central Fortuna in the Jacaguas Valley, while the highest rainfall recorded in a United States Weather Bureau rain gage was 10.7 in. at the Guayabal Dam on the Jacaguas River.

That this record has been exceeded in the past is shown by an examination of the Climatological Reports for the Porto Rico Section of the Weather Bureau. This report for November, 1909, p. 84, states "During the night of Nov. 12-13, 1909, amounts (of rainfall) rang-

*Division Engineer, Porto Rico Irrigation Service, Guayama, Porto Rico.

MAXIMUM RUNOFF OF VARIOUS STREAMS IN THE DISTRICT UNDER DEVELOPMENT BY THE PORTO RICO IRRIGATION SERVICE

| River and station | Catchment area, sq.mi. | Date of flow | Max. peak sec.-ft. | Flood flow sec.-ft. per sq.mi. | Average run-off for 24 hr. Max. sec.-ft. | Average run-off for 24 hr. Sec.-ft. per sq.mi. | Average run-off for 48 hr. Max. sec.-ft. | Average run-off for 48 hr. Sec.-ft. per sq.mi. |
|---|---|---|---|---|---|---|---|---|
| La Plata River at Carite Dam | 7.92 | May 13, 1909 | 13,034 | 1646 | 3547 | 448 | | |
| La Plata River at Carite Dam | 7.92 | May 12-13, 1909 | | | | | 1978 | 250 |
| La Plata River at Carite Dam | 7.92 | Aug. 22, 1909 | | | 1882 | 238 | | |
| La Plata River at Carite Dam | 7.92 | Oct. 7, 1911 | 6,670 | 842 | | | | |
| La Plata River at Carite Dam | 7.92 | Oct. 8, 1912 | 5,325 | 672 | 1427 | 180 | | |
| Patillas River at Patillas Dam | 24 | May 13, 1909 | 19,635 | 818 | 3995 | 166 | | |
| Patillas River at Patillas Dam | 24 | Nov. 12, 1909 | 19,105 | 796 | 3324 | 138 | 3187 | 133 |
| Patillas River at Patillas Dam | 24 | Oct. 8, 1912 | 13,958 | 582 | 3477 | 145 | | |
| Guamani River above Guayama | 6 | Aug. 3, 1909 | 2,450 | 408 | 686 | 114 | | |
| Guamani River above Guayama | 6 | Sept. 7-8, 1910 | | | 1826 | 304 | 1463 | 244 |
| Guamani River above Guayama | 6 | Oct. 8, 1912 | 2,850 | 475 | 1156 | 193 | | |
| Descalabrado River at Military Road | 18 | Nov. 12, 1909 | 13,300 | 739 | 2095 | 116 | | |
| Descalabrado River at Military Road | 18 | Oct. 7-8, 1912 | | | | | 1316 | 73 |
| Descalabrado River at Military Road | 18 | Oct. 8, 1912 | 11,250 | 625 | 1602 | 89 | | |
| Jacaguas River at Guayabal Dam | 43.38 | Nov. 12, 1909 | 45,000 | 1037 | 2410 | 56 | | |
| Jacaguas River at Guayabal Dam | 43.38 | Oct. 8, 1912 | 60,000 | 1383 | 7573 | 175 | | |
| Jacaguas River at Military Road | 51 | Nov. 12-13, 1909 | | | | | 6303 | 124 |
| Toro Negro River at Toro Negro Dam | 3.33 | Oct. 27, 1911 | 10,220 | 3069 | 355 | 107 | | |
| Toro Negro River at Toro Negro Dam | 3.33 | Apr. 19, 1912 | 9,100 | 2733 | 239 | 72 | | |
| Toro Negro River at Toro Negro Dam | 3.33 | Oct. 7-8, 1912 | | | | | 1022 | 307 |
| Toro Negro River at Toro Negro Dam | 3.33 | Oct. 8, 1912 | 10,758 | 3231 | 1149 | 345 | | |
| Doña Juana River at Tunnel | 1.67 | Oct. 8, 1912 | 1,650 | 988 | 405 | 243 | | |
| Doña Juana River at Tunnel | 1.67 | Nov. 9, 1912 | 1,535 | 919 | 379 | 227 | | |
| Doña Juana River at Tunnel | 1.67 | Nov. 8-9, 1912 | | | | | 350 | 210 |
| Coamo River at Military Road | 42 | Nov. 13, 1909 | 28,100 | 669 | 4900 | 117 | | |
| Coamo River at Military Road | 42 | Nov. 12-13, 1909 | | | | | 3850 | 92 |
| Coamo River at Military Road | 42 | Oct. 8, 1912 | 18,285 | 435 | 3944 | 94 | | |

Catchment areas given to hundredths of a square mile were determined by surveys made for this particular purpose. Other catchment areas were determined from general maps of the Island of Porto Rico.

The Plata, Toro Negro and Dona Juana catchment areas are in the mountains on the north side of the divide. All others are on the south side but extend to the main divide with the exception of the Descalabrado catchment basin, which is located in the foothills.

ing between 10 and 13 in. were recorded at Guayama, Humacao and Yabucoa, between sunset and sunrise."

The area quoted includes a portion of the district drained by the rivers noted in the table. In other sections of the island still heavier rains have been recorded. The August, 1910, report gives the following figures:

Rainfall 23.00 in. in 23 hr. at Adjuntas, on Aug. 9, 1899.

Rainfall 17.02 in. in 24 hr., near Loquillo, on July 6, 1901.

From 1898 to August, 1910, the Weather-Bureau reports for Porto Rico show 17 records of rainfalls of 10 in., or over in 24 hr., so it will be seen that rainfalls equal or greater than that of the night of Oct. 7-8 may be expected in this district every few years.

Of the floods recorded during this storm of Oct. 8, 1912, the maximum rate of runoff recorded was 3231 sec.-ft. per square mile for the 3.33 square mile drainage area of the Toro Negro River. The next lower record was 1383 sec.-ft. per square mile for the 43.38 square miles of catchment of the Jacaguas River above the Guayabal Dam.

During the 13 hours of rainfall, the rainfall at Guayabal was 10.7 in.; the total rainfall in the catchment area of the Jacaguas River above Guayabal has been computed as 22,827 acre-ft. The flood runoff from this same area, deducting the normal flow of the river for the flood interval, was 17,356 acre-ft. The runoff was 76% of the rainfall.

During the same storm, the runoff at Carite Dam from the La Plata catchment was 90% of the 7.4 in. of rain which fell in 13 hours.

While A. T. Dickey in ENGINEERING NEWS, of Nov. 6, 1913, p. 945, gives rainfall figures for Galveston, Tex., which exceed in quantity and frequency the heavy rainfalls in this district, the writer has been unable to locate any record of greater runoff in cubic feet per second per square mile of catchment area.

## A Power Cable Suspended in a 400-Ft. Bore Hole

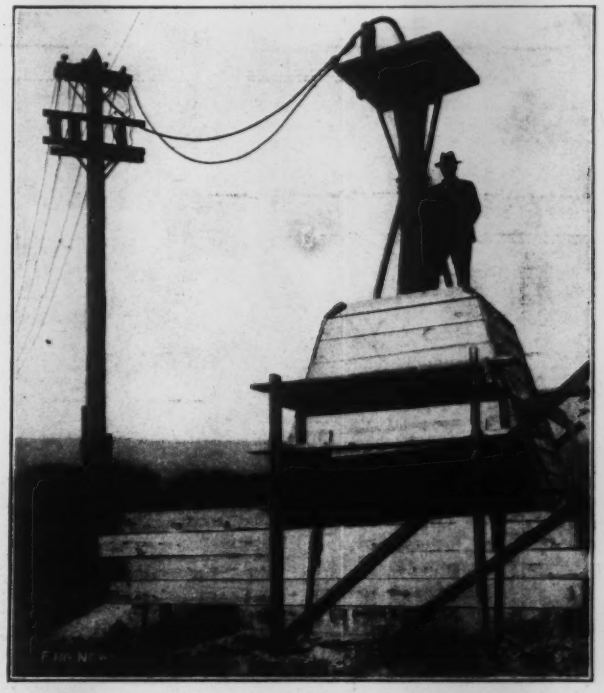
BY F. C. PERKINS*

The accompanying figure shows an unusual installation of power cable, running to coal-mine workings, where it was not advisable to use the mine shaft. Somewhat over a year ago it became necessary for the Lehigh Valley Coal Co. to supply more electric power to the inside workings of the Maltby Colliery (in the Wyoming Valley on the west side of the Susquehanna River, about four miles above Wilkes-Barre). Electric power (500 volts, direct current) was to be used to drive four separate inside electric hoists, three electric haulage locomotives, two large electric pumps and five small pumps. The fact that the main switchboard was to be over 5000 ft. in from the foot of the shaft complicated matters, as the problem of stringing a line of this length through the inside workings, suspending it solidly, and insulating it sufficiently so that there would be no danger from electric shock, presented so many difficulties. It was then decided to drop the line through a borehole to the switchboard. The hole was 390 ft. deep and some 400 ft. of cable was needed, weighing about 3550 lb.

*665 Prospect Ave., Buffalo, N. Y.

As the cable was to be suspended in a smooth borehole, it could be supported only at the ground surface. For this purpose, an iron pipe (10 in. outside diameter) was set up over the hole and a heavy concrete base built around it and about 8 ft. high. The pipe projects a little over 4 ft. above the top of the concrete to avoid overtopping by spring floods. Inside and above the 10-in. pipe is a section of 6-in. (outside diameter) supported on a flange at the top of the larger pipe. A cast-iron plate, 12 in. square, rests on a flange of the upper pipe, being also braced as shown.

After the cable was passed down and the upper end threaded through the sleeve and plate, an iron split collar was fastened above the plate. The armor wires were



A 500-VOLT POWER CABLE SUSPENDED IN A BORE HOLE

bent down over it and clamped so that the weight is carried by the armor wires.

The cable itself is a two-conductor type (600,000 circ. mils each). Around the central conductor (61-wire core) is 1/8 in. of vulcanized rubber and a layer of tape. The second conductor (21 seven-wire strands) is assembled concentric with the first and covered with 9/64 in. of rubber and a layer of tape. These are 31 No. 6 B.w.g. galvanized-steel armor wires bedded in jute serving and similarly covered by jute saturated with weather-proof compound.

The installation was made under the direction of Chas. W. Beers, Electrical Engineer of the Lehigh Valley Coal Co. The cable was made and laid by the Hazard Manufacturing Co., Wilkes-Barre, Penn.

**A National Foreign Trade Council** consisting of thirty men of national prominence was provided for by the National Foreign Trade Convention held at Washington on May 27 and 28. The president of the convention, Mr. Alba B. Johnson, of Philadelphia, president of the Baldwin Locomotive Works, is to appoint the thirty members of the council, which is to arrange for a permanent organization to foster the export trade of the United States.

# Construction Work on the Railway Exchange Building, St. Louis, Mo.

The Railway Exchange Building, in St. Louis, is a combined store and office building, 21 stories high (308 ft. from the sidewalk), and covering the entire block 228x271 ft. between Olive, Locust, 6th and 7th Sts. The first seven stories are occupied by a large department store, and the upper floors are used for office purposes. The frame is of steel; the floors are reinforced concrete, as described in our issue of Jan. 1, 1914, p. 32.

The foundations are 110 concrete piers carried through gravel and clay down to rock at about 75 ft. below street grade. These are circular, 6 to 7 ft. diameter. Most of these were built in open wells lined with steel sheet-piling driven to a depth of 50 ft. below the old basement, but the 38 piers on the street sides were put down by the pneumatic system, to provide against any danger from sliding, or caving of the ground.

The steelwork was handled and placed by four guyed derricks and two stiff-leg derricks; these were of 20 tons capacity, with 80-ft. booms, and each operated by a 100-hp. electric motor. The steel framing aggregated some 10,000 tons.

The concrete mixing plant was placed in the basement, and the arrangement of the material bins is shown in Fig. 1. The gravel and sand were delivered in dump wagons which drove in from the street (at separate points) and dumped their contents over grated openings in the first floor, directly above the storage bins, as shown at $X$ and $Y$ (Fig. 3). These materials were then delivered by belt feeders to elevating bucket conveyors which raised them to the working bins over the mixer. A third bucket conveyor elevated the cement to its working bin, which was partitioned off from the sand bin.

The measured quantities of gravel and cement were fed automatically to the batch hopper above the mixer by means of gates operated by horizontal compressed-air cylinders, one cylinder controlling the gaged gravel and the other controlling the cement and washed gravel. Each cylinder had its piston rod fitted with stop engaging levers on the shafts of the gates. This device was designed by the contractors, and is shown in Fig. 2.

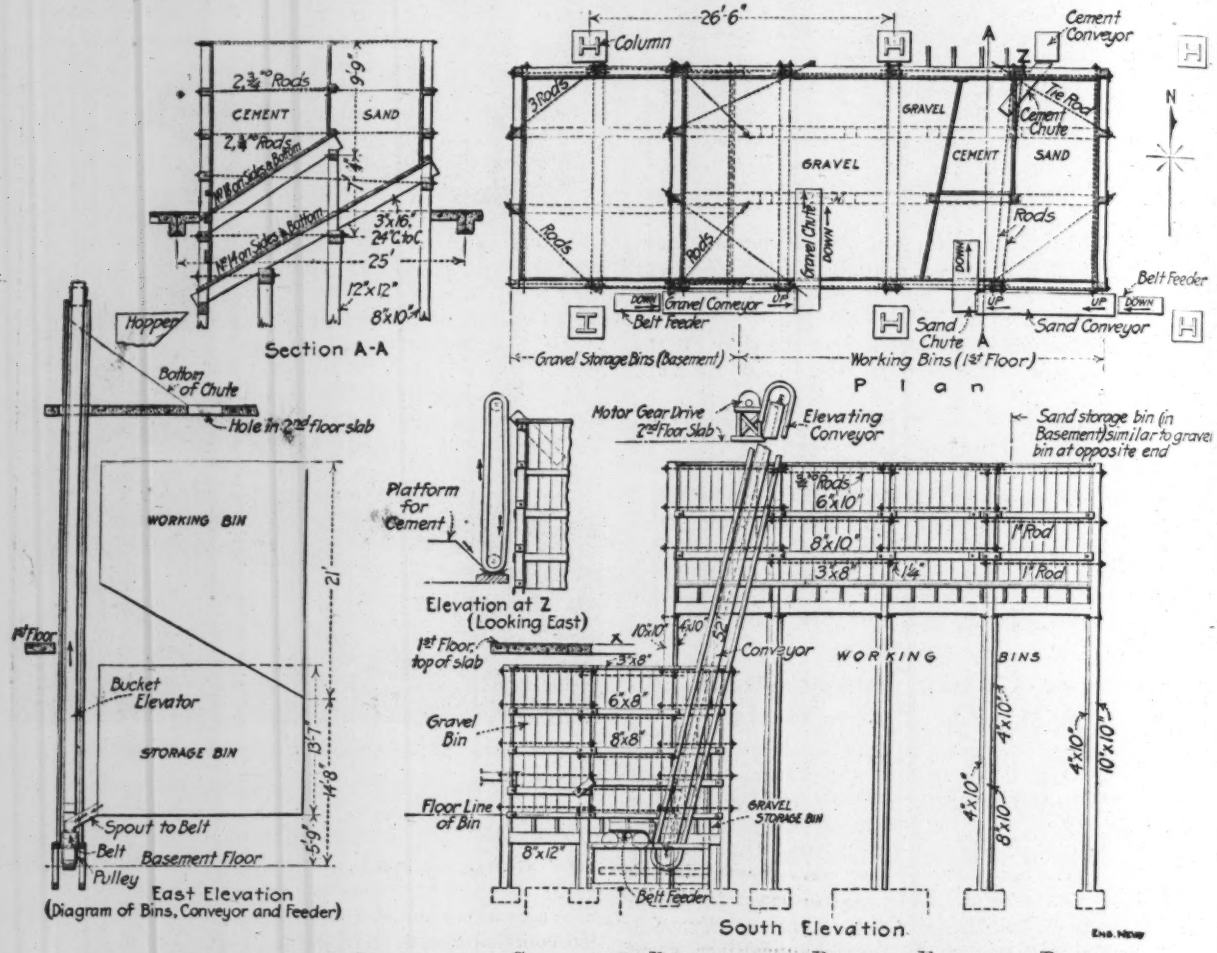



FIG. 1. ARRANGEMENT OF BINS FOR THE CONCRETING PLANT AT THE RAILWAY EXCHANGE BUILDING, ST. LOUIS, MO.

The storage bins had capacity for 500 cu.yd. of gravel and 250 cu.yd. of sand, while the working bins had capacity for 300 yd. of gravel and 150 yd. of sand. The mixer drum was of 2-yd. capacity.

From the mixer the concrete was distributed by 1½-yd. cars on a loop track of 24-in. gage, serving four ele-

vator towers, the cars being handled by a 3-ton electric locomotive. At the tower, the car dumped the concrete into a 1½-yd. elevator bucket. The plan, Fig. 3, shows how the track was laid out to avoid the wells of the foundation piers.

Each tower had inclined chutes extending in two directions. These chutes were in section 30 to 50 ft. long, each having a hopper at the upper end to receive the concrete from the adjacent section. These served the entire area of the floor, as each section of chute could be swung in a circle. All concrete was delivered in place in this way, which is indicated by Fig. 3.

The four tower elevators were operated from two double-drum electric hoists in the basement, each hoist being driven by a 100-hp. electric motor, and the cables being led under the first floor to the towers (Fig. 3). Shaft or platform elevators were provided for handling the reinforcement and other material. Two of the concreting towers were located conveniently in the elevator shafts of the building.

The Westlake Construction Co., of St. Louis, Mo., was the general contractor and executed the entire work. The

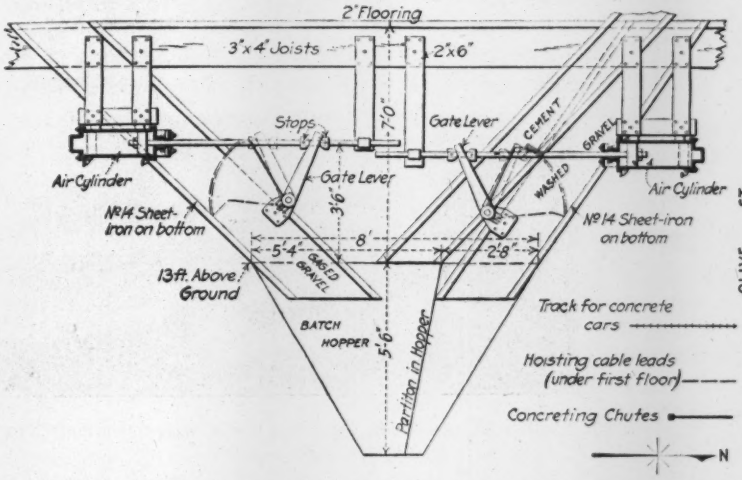



FIG. 2. AIR-OPERATED VALVES FOR REGULATING THE SUPPLY OF MATERIAL TO THE CONCRETE MIXER

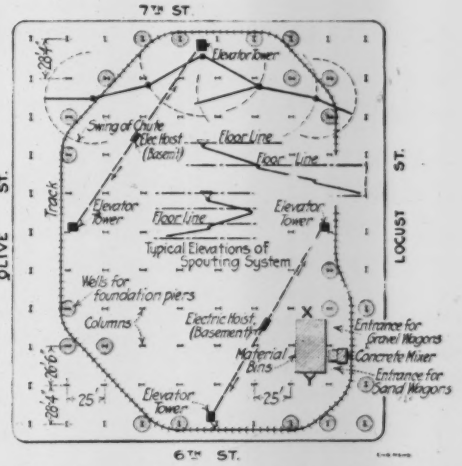



FIG. 3. PLAN AND PART ELEVATION OF CONCRETE DISTRIBUTING PLANT AT THE RAILWAY EXCHANGE BUILDING, ST. LOUIS, MO.

pneumatic caisson foundations were put down by the Foundation Co., of New York. The progress of the work is indicated by the following list of dates:

| | |
|---|---|
| Old buildings vacated | Feb. 1, 1912 |
| Wrecking old buildings commenced | Feb. 1, 1912 |
| Foundation wells commenced | Mar. 5, 1912 |
| Last foundation well concreted | July 15, 1912 |
| Steel erection commenced | July 1, 1912 |
| Steel erection completed | Dec. 1, 1912 |
| Floor concreting commenced | July 10, 1912 |
| Roof concreting completed | Jan. 1, 1913 |
| First occupation of store floors | Jan. 15, 1913 |
| Building entire completed | Oct. 1, 1913 |

## Removal of Oil and Gas from Drinking Water

A well at Joliet, Ill., 1570 ft. deep, produced water impregnated with gas and oil, and continual pumping produced no change in the conditions. To make the water suitable for use, C. D. O'Callahan, City Engineer, built an aërating plant, with entirely satisfactory results at very small cost. The treatment is described by him as follows in a paper in the 1914 *Proceedings* of the Illinois Water Supply Association.

To determine whether aëration would effectively remove the oil, a small plant was constructed that would take about 7% of the flow of the well. This had steps, with a tank at the bottom, the water splashing down these steps into the tank. At the base, air was forced through the water and while the means were crude, they indicated that a proper plant on the same general order would make the water usable.

A concrete reservoir was constructed, 75x20 ft., and 7 ft. deep, divided into 6-ft. compartments, and having a longitudinal center wall. At one end a series of steps was constructed, and the water from the well was delivered into a compartment from which it flowed over the steps. The partitions forming the several compartments in the reservoir, acted as baffles, the water passing over one and under the next one and so on, up one side and back on the other.* Through perforated pipes resting on the bottom of the reservoir, air was delivered to each compartment at a low pressure, simply allowing the air to bubble up to the surface, causing very little agitation on the surface of the water. The oil was brought to the surface by means of the air flowing through it and was collected on the partitions and sides of the first compartment of the reservoir. The gas was released by the water being broken up as it passed over the steps and also by the air passing through it.

The water has been delivered into the mains five months, and no complaints have been made. The water is as tasteless and odorless as any of the artesian water. This well delivers about 1,000,000 gal. per 24 hr. The city had expended about $20,000 in drilling and equipping this well. By making this water fit for use, at least $20,000 was saved. The cost of the necessary change in machinery and the construction of the reservoir was less than $3000.

**Locomotives Burning Oil** instead of coal as fuel have been required on the railways operating in the New York State Forest Reserve since 1909, during the summer season from Apr. 15 to Nov. 1, on trains run between 8 a.m., and 8 p.m. On the New York Central lines it is stated that during the season of 1913, compliance with this order increased the operating expenses of the company by $90,000. The railway company recently appealed to the Public Utilities Commission for permission to operate a new type of coal-burning locomotive equipped with special appliances for preventing the emission of sparks and the dropping of coal from the ash pan. In an opinion rendered on May 20, the Commission denied the application, holding that while the improved appliances on the locomotive were deserving of high commendation and would probably meet requirements under ordinary conditions, the uncertainty that the appliances would be kept in repair so that neglect might cause the emission of sparks and coals made it advisable to continue use of oil fuel.

*Such a trap tank for removing oil from water at a railway roundhouse was described in our issue of May 21, but in that case the baffles only were used, there being no steps or compressed air.

## Examination for Junior Civil Engineer, Interstate Commerce Commission

An examination was held at various points by the United States Civil Service Commission on May 6, for the position of Junior Civil Engineer in the Interstate Commerce Commission, under the Congressional act providing for the valuation of property of common carriers.

The salaries range from $1200 to $1500 per annum, with necessary expenses when absent in the field; the appointments being principally away from headquarters.

The following subjects with relative weights indicated were given:

| | |
|---|---|
| (1) Mathematics; algebra, geometry and trigonometry... | 30 |
| (2) Theory and practice of railway surveying..... | 30 |
| (3) Education, training and experience..... | 40 |
| Total ..... | 100 |

All applicants were required to attain an average percentage of at least 70 on the first two subjects combined, which are covered in the first two years at a reputable civil-engineering school. Applicants need not show that they actually attended an engineering school; but they must have had at least two years' experience (practical field) in civil engineering in railway work, six months of which was spent in running the transit.

Seven hours were allowed for the examination. The use of the slide rule was allowed in the surveying section of the examination.

MATHEMATICS

Select four of the following problems:

(1)—Construct a triangle; given the base AB, the angle C, and the medium C to the base AB. Give complete construction and proofs.

(2)—$2 \sec^{-1} x = \tan^{-1} y$.

Find y in terms of x.

(3)—Multiply $a^{\frac{3}{4}}b^{-\frac{1}{4}} + 2a^{\frac{1}{4}} - 3b^{\frac{1}{4}}$ by $2b^{-\frac{1}{4}} - 4a^{-\frac{1}{4}} - 6a^{-\frac{1}{4}}b^{\frac{1}{4}}$.

(4)—Two chords C and c have the distance d between them. Find the radius of the circle.

(5)—This was a typical simultaneous-equation problem involving a race between A and B in which each is given a handicap over the other; and the time in which one defeats the other in a mile race, is given. Find how long it took each to run the mile.

THEORY AND PRACTICE OF RAILROAD SURVEYING

Select four of the following problems:

(1)—"A" is the P.C.; "B" the P.C.C.; and "C" the P.T., of a compound curve; "I" the point of intersection of the tangents; "A" is station 121 + 42; "B" is station 126 + 22. AB is a 2° curve, BC is a 4° curve and the angle IAC is 16°-36′. Take radius of 1° curve = 5730 ft.

(a)—Find the station number of "C."

(b)—Describe how you would run in the curve if B is inaccessible; giving values of all the deflection angles used.

(c)—How would you locate stations 134 and 135?

(2)—Given a No. 7 frog, the gage 4 ft. 8½ in., distance between centers 13 ft. (a)—Explain in detail how you would unite the main line with a parallel siding when the reversing point is at the frog point B. (b)—Assuming the P.S. at station 100 + 00 give stationing of P. F. and P. T. to the nearest tenth of a foot.

(3)—A −1.1% grade meets a +1.3% grade at station 312, whose elevation is 155 ft. These grades are to be connected by a vertical curve 400 ft. long. Give in tabulated form the original elevations, the corrections and the corrected elevations for every 50 feet of curve.

(4)—An earth cut is to have a 14-ft. base, and sideslopes of 1½:1. Assuming the ground surface at each station has a transverse slope of 1 on 5, and with the data given in the table below, fill in the blank portion of the table. Using this complete table compute the volume of the cut in cubic yards.

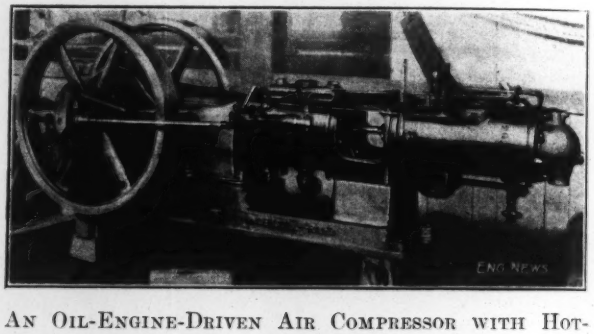
| Station | Ground | Grade | Left | Center | Right |
|---|---|---|---|---|---|
| 161 | 178.8 | 174.0 | ..... | ..... | ..... |
| 162 | 180.2 | 173.0 | ..... | ..... | ..... |
| 163 | 177.1 | 172.0 | ..... | ..... | ..... |
| +50 | 175.0 | 171.5 | ..... | ..... | ..... |
| 164 | 176.0 | 171.0 | ..... | ..... | ..... |

(5) State in proper order, but do not describe in detail the field adjustments of the engineer's transit. Explain why these adjustments are necessary and how imperfect [illegible] in them affect the accuracy of the observations.

## A New Oil-Engine Air Compressor

The Ingersoll-Rand Co. has had upon the market for some time a horizontal air-compressor driven by a gasoline engine, the gasoline cylinder being tandem with the air cylinder. The increase in the market price of gasoline two years ago made this a rather expensive machine to operate and the company therefore undertook the development of a machine which would use kerosene instead of gasoline as fuel.

The accompanying cut shows the machine which has been developed to meet this need. As shown, the oil-engine cylinder is tandem with and directly back of the air-compressor cylinder. The oil-engine cylinder is fitted with a hot bulb for ignition. In order to start the machine, it is necessary to heat this bulb by a torch, directing the flame against its external surface. After the bulb is once heated, the engine runs continuously with no further trouble regarding ignition; and the advantages of dispensing with the usual batteries, spark plugs, magnetos,




AN OIL-ENGINE-DRIVEN AIR COMPRESSOR WITH HOT-BULB IGNITION

electric connections, etc., of the ordinary gasoline engine, which are always apt to give more or less trouble in the hands of inexperienced operators, are not to be overlooked.

The engine is operated on the four-stroke cycle. At the end of the compression stroke (the compression being carried to about 85 lb. gage pressure) the fuel is injected in finely atomized form into the interior of the hot bulb. Injection of the fuel is done by a tiny pump delivering a fine spray through an atomizing nozzle. The fuel pump is of simple design, consisting merely of a steel rod plunger with a set of intake and outlet valves having a small and a large steel ball in series. The nozzle used for atomizing is a needle valve having a comparatively large orifice. The needle is kept closed by a heavy spring until opened by the pressure from the pump to deliver the atomized blast. Experiments have been conducted upon the form of nozzle to secure the best atomizing effect and it is stated that success has been attained by attention to the proper shape of the needle tip and of the nozzle opening.

The governor in the flywheel of the engine operates to vary the throw of the fuel pump plunger and therefore the quantity of fuel delivered to the engine at each

stroke. In order that the machine shall operate successfully at variable loads, it is necessary that the hot bulb be kept at uniform temperature. If the temperature falls too low, the fuel may fail to ignite. If too high a temperature is reached, the fuel may be cracked and incomplete combustion may result.

The common method employed in oil engines to regulate the heat of the bulb is the injection of a very small quantity of water into the clearance space. It is necessary to vary the amount of water delivered as the load on the engine varies. The designers of the engine illustrated state that the amount of water injected is controlled thermally. A simple thermostat is placed in the combustion chamber and its movements control the admission of the water to the cylinder. By this appliance it is said that the operation is made nearly automatic.

This machine is at present manufactured in one size only, with an actual capacity when run at 325 r.p.m. of 66 cu.ft. of free air at 100 lb. pressure per minute. The fuel consumption at this speed under average conditions is about 2.2 gal. of kerosene per hour. The weight of the complete machine is 3000 lb., and it occupies a floor space of 8 ft. 10 in. by 2 ft. 5 in.

## Conditions of Employment and Compensation of Civil Engineers*

By Carl H. Fuller†

The object of every professional organization is the betterment of its individual members; and the matter of personal income is bound to have its reflex influence on the purely professional or technical aspects of that society.

From the very nature of things, every paper presented before this Society reflects the financial success of the writer, and there are without a doubt a large number of members, who, if it were not for the handicap of family and the necessity of providing for them, would be glad to contribute very materially to the *Transactions* of the Society. Therefore, if the Society cannot give serious consideration to the material, individual condition of its membership, it will fail to represent the ideals of the majority; thus, the matter of personal or professional income becomes as much a matter of concern to the Society collectively as it does individually.

Conservation and scientific management have become quite a fetish in the engineering profession, yet, as a whole, it is more extravagant and wasteful of its energies than any other body of intelligent labor in the world.

If this statement is challenged, one item alone will be considered. The average engineering job (not position) lasts from 3 to 18 months, occasionally longer. In the transition from one job to another the average engineer will lose at least one month, and, if his last project has been finished late in the year, he is likely to lose 3 or 4 months.

Without resorting to statistics, the writer thinks it may safely be assumed that the average engineer loses on this account fully one-tenth of his time and income, through no fault of his.

If this waste can be eliminated—for waste it is—not only will the average income be raised, but a very material difference will be made in the minimum income; for this waste naturally applies to those whose incomes fall in lower half of the average, and among whom there are many able men.

From these thoughts arise two ideas: (*a*) Can the Society as a body wield an influence that will tend to increase the compensation of its members and the profession at large so that it will be consistent with services rendered? (*b*) Can it do anything to prevent the loss of time of its members? The writer thinks it can, and, furthermore, that it is one of the obligations of its existence, because no other body of men is qualified to do this.

There are many phases to this proposition. It is the biggest problem that has ever been presented to the Society. Is the Society going to table it, after some academic discussion, or is it going to seek a remedy? The writer would suggest that a standing committee be appointed to continue the work that has been started.

As to the conservation of the time lost, the Society can, if it will, afford immediate and effective results by the establishment of a secretaryship or bureau, under the direction of a competent engineer who knows the work and the men, the duties of which will be to furnish a clearing house for the services of its members. In this the employing member will receive as much benefit as he who is seeking employment, for the reason that a properly conducted department of this kind will try to place the right man in the right place, instead of "bleeding" an unemployed man who can ill afford it.

The writer is of the opinion that every member who has used the employment agency to secure help has been disappointed in the results obtained, because the employment agent is only looking for his commission. In one instance an agent offered to divide his commission if the writer would employ his clients and discharge them again when the fee had been paid.

Some member on whom fortune has smiled, in the way of successful positions, may object that it lowers the dignity of the Society to go into the employment agency business; but, who has a greater right to conserve the time and compensation of its membership than this honorable body?

Each and every member belongs to this Society for one of two reasons; either to derive some benefit from the organization or to confer some good on his fellow-members. Therefore, while the Society is caring for the intellectual welfare of its members, why not go a step farther, and provide for their material welfare, thereby permitting them to derive greater intellectual benefit?

The writer hopes that there will be further discussion on this subject from the majority of the membership whose inome falls below the average line, in order that some light may be obtained on the whys and wherefores.

[Since the above was written the Society has made another attempt to collect statistics regarding the compensation of its members in all grades. Nelson P. Lewis, Chief Engineer of the Board of Estimate and Apportionment, New York City, is Chairman of the committee, in place of the late Alfred Noble. It is hoped that every member of the Society will make returns, as in this way only can a fair average be obtained.—Editor.]

*Extracts from a discussion of the Report of the Committee of the American Society of Civil Engineers (reprinted in our issue of Jan. 22, 1914, p. 166), May issue of the "Proceedings" of the American Society of Civil Engineers, p. 1597.

†Engineer of Maintenance-of-Way, Macon Ry. & Light Co. and Assistant Engineer, Central of Georgia Ry., Light & Power Co's., Macon, Ga.

# New Water Intake at Milwaukee

*SYNOPSIS—A 12-ft. tunnel is being driven 4000 ft. into the lake to a shaft rising to a crib from which 6-ft. pipes will extend 2500 ft. to submerged intake cribs. A steel crib will be sunk to allow the contractor to put down the shaft and drive the tunnel from both ends. An air-lock is in place in the tunnel but so far the work is in solid shale and compressed air is not used. Two shore tunnels and a new pumping station will be built later. Description of methods of construction, with details of engineer's record system.*

The city of Milwaukee, Wis., takes its water-supply from Lake Michigan by means of a 7½-ft. brick-lined tunnel 3146 ft. long, extending under the bed of the lake from a shore shaft at the North Point pumping station to a shaft opening into the well of a crib, beyond which extend two 5-ft. cast-iron pipe lines 5000 ft. long, ending in submerged cribs in 60 ft. of water with 45 ft. of water over the cribs. The daily capacity of flow is 75,000,000 gal. with a drop of 4 ft. in the pump well, or 95,000,000 gal. with a drop of 8 ft. During the summer of 1911, the maximum rate of consumption exceeded 90,000,000 gal. at times, but this was not reached in 1912, owing to the wet season. The average daily consumption has increased from 33,805,000 gal. in 1908 to 47,556,000 in 1912, and is estimated to reach 60,000,000 gal. by 1917.

As the maximum rate of consumption is approximately double the average rate, it became evident that an additional supply must be considered. This could be provided in two ways: (1) by increasing the capacity of the present intake (either by lowering the pump wells or putting a screw pump in the shore shaft); (2) by building a second intake. The latter method was adopted in 1912, for reasons stated by the City Engineer as follows: (1) The city should have more than one means of supply, for purposes of safety; (2) the growing demand indicated that an additional intake would have to be built in the near future, even if the capacity of the present plant should be increased; (3) for the past few years a good deal of sand has been coming in with the water during the heavy pumping in the summer which probably indicates erosion along the line of the tunnel and makes it inadvisable to increase the velocity of flow.

The work now in progress consists of a 12-ft. tunnel (80 ft. below datum), extending 4000 ft. northeast from a shore shaft (on the line of Linwood Ave.) to an intake shaft at a crib, from which two 6-ft. steel pipe lines will extend 2500 ft. along the bed of the lake to submerged cribs in water 60 ft. deep. From the shore shaft a 9-ft. tunnel (20 ft. below datum) will extend under the land to the present pumping station, a distance of 5300 ft. The capacity of this intake will be about 200,000,000 gal., and its cost (with the shore tunnel) is estimated at $850,000.

When the capacity of the present pumping station is reached, a new one will be built, due west from the intake tunnel, and reached by a 9-ft. shore tunnel. At that time, the intake capacity will be increased further by building two additional pipe lines and submerged intakes beyond the crib. The general situation is shown in Figs. 1 and 2.

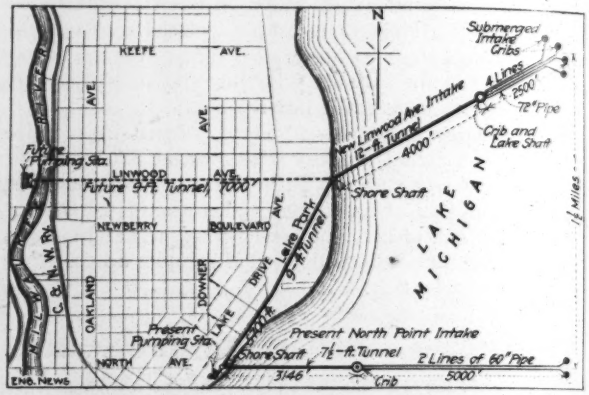



FIG. 1. PLAN SHOWING POSITION OF PRESENT AND FUTURE INTAKE TUNNELS AND PUMPING STATIONS FOR THE WATER SUPPLY OF MILWAUKEE, WIS.

The work is being done under the direction of Fred G. Simmons, Commissioner of Public Works, and Joseph A. Mesiroff, City Engineer, who is personally in charge of the work. The contract for the shore shaft lake tunnel and intake shaft was let Apr. 29, 1913, to Joseph Hanreddy, of Chicago, at $450,000. The contract for the crib for the intake shaft was let in March, 1914, to the Wisconsin Dredge & Dock Co., of Sheboygan, Wis., at $89,700. The contract for the two pipe lines and submerged cribs has not been let.

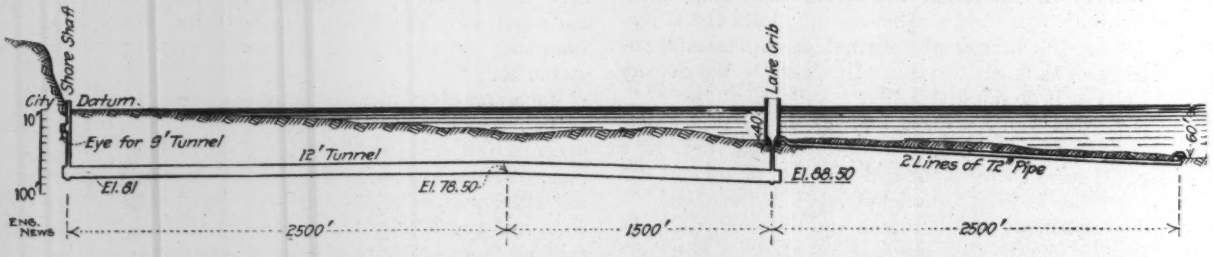



FIG. 2. PROFILE OF LAKE INTAKE TUNNEL AND PIPE LINES; MILWAUKEE, WIS.

## SHAFTS

SHORE SHAFT—This was located in the shallow water at the foot of the 100-ft. bluffs forming the coast line, and is about 25 ft. from the shore line. It is opposite a public park and the material excavated from the tunnel is being dumped along the foot of the bluffs to form an

extension of the park and a part of the projected lake-shore drive. This is shown in Fig. 3. The shaft is 15 ft. diameter and 80 ft. deep from the datum line (lake level) to the floor of the tunnel opening, or 85 ft. to the bottom of the sump. At 20 ft. below datum are two eyes or openings for the 9-ft. shore tunnels to the present and future pumping stations. Each of these will have a gate well and chamber, as shown in Fig. 4.

The shaft is lined with 18 in. of concrete, belled out at the level of the tunnel roof to give extra thickness at the junction of the shaft and tunnel lining. After the completion of the work, the shaft will be covered with a concrete slab (8 ft. above datum) carried by I-beams incased in concrete. A 36-in. manhole shaft will extend to the grade line, 12 ft. above datum.

LAKE SHAFT—This will be 15 ft. diameter, with an 18-in. concrete lining, the top being curved out to a diameter of 19 ft. in the floor of the crib (Fig. 5). Work on the shaft will be commenced this summer, as soon as the crib can be placed, so that the tunnel may be driven from both ends.

### CRIB

The crib of the Milwaukee intake is only an intermediate point on the intake, and in this respect it differs from the arrangement at Chicago and some other lake cities. In the latter case, the crib forms a well connected with the lake by ports in the sides, and the intake shaft is extended up into this well by a steel cylinder having intake gates in its wall. At Chicago, also, the

FIG. 3. SHORE SHAFT OF NEW INTAKE TUNNEL AT MILWAUKEE, WIS.
(The concrete mixing plant is at the right of the shaft; above it is the platform; for cars taking material down the cable incline from the top of the bluffs.)

For the upper end, a circular shell was formed by driving steel sheet piling 45 ft. long, and within this the excavation was commenced. A hole for the eye of the first shore tunnel was cut in this sheeting by oxyacetylene torches. The shaft timbering was octagonal in plan, with 80-in. sides and an inside diameter of 19 ft. across the sides. It is of 12x12-in. timbers, each alternate course having drift-bolts extending through three courses. Steel forms were used for the concreting and after the lining was completed, a two-cage elevator was installed as part of the working plant for the tunnel.

The shaft is in clay and hardpan at the upper end, and the greater part of its depth is in brown shale, with some soapstone layers. Very little water was encountered. The excavation of the shaft was commenced July 17, 1913; the concrete lining was commenced Sept. 12, and completed Sept. 27, 1913. The shaft is shown in Fig. 4.

crib has a superstructure with accommodation for attendants who handle the gates and in winter see to keeping ice from the gates and ports.

The Milwaukee crib has no ports and its well is connected with the lake only through the long pipe lines, while the shaft to the tunnel opens directly through the floor of the well. Consequently, no attendants will be necessary. The well will be roofed and above the roof will be a light and fog whistle as a warning to vessels, as shown in Fig. 5.

The principal reason for the Milwaukee intake arrangement is that the crib will be in 40 ft. of water, which is considered about the limit of depth in which the shell for such a structure can be placed economically, while a greater depth is desirable for the source of supply and is within reach by pipe lines. At Chicago, however, the lake bottom is much flatter, and while the cribs

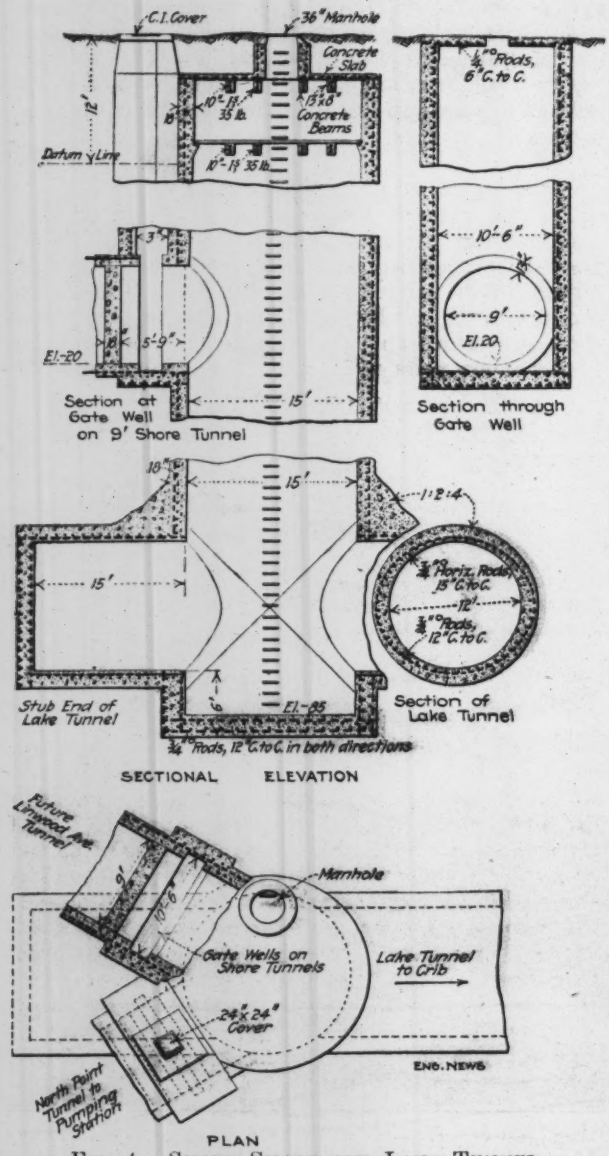



FIG. 4. SHORE SHAFT AND LAKE TUNNEL

are in about 40 ft. of water, an extension of several miles would be required to reach a 60-ft. depth.

Each pipe inlet through the well of the crib is provided with a gate chamber, the gates being operated by hand gear. Should it be necessary to shut off the water from the tunnel, men will go out to the crib to close the gates.

The general design of the crib is shown in Fig. 5. It is 60 ft. outside diameter, with a wall 10 ft. 6 in. thick, giving 39 ft. clear diameter for the well. The four pipe inlets will be built, but two of these will be closed with blank flanges until such time as the additional pipe lines are laid. Special castings will connect the inlets with the pipe lines, and heavy riprap will be deposited to support and cover these castings, as shown. In order to have the tunnel completed within contract time (May 1, 1915), it will be necessary for the contractor to work from both ends, and for this reason work on the lake shaft must be commenced before the end of 1914. It is essential, therefore, that the shell for the crib of this shaft should be sunk in place before the stormy weather of the autumn begins, as such work would then be difficult and dangerous.

The steel structure of the crib, Fig. 6, consists of two concentric cylinders 60 ft. and 19 ft. diameter, connected by 12 radial lines of vertical bracing and three horizontal circular trusses. The annular space has a steel floor. It is subdivided by a circular line of vertical bracing (with diagonals to the outer shell), and against this will be fitted the lagging for the concrete lining. After the crib is placed and the concrete work around the walls is finished, the tunnel contractor will sink the lake shaft and proceed with the tunnel in a westerly direction, 1500 ft. When the above is completed, the crib contractor will remove the inside cylinder and bracing as shown in Fig. 6 and complete the crib.

To facilitate the accurate placing of the crib, the engineers will locate and drive a semicircular line of piling at the site, to serve as a guide. Against this the crib will be sunk by water ballast, when towed into position.

## INTAKE TUNNEL

The intake tunnel is of circular section, 12 ft. diameter, with a length of 4000 ft. between the shore shaft and the lake shaft. As shown by the profile, Fig. 2, there is a slight ascending grade from the lake shaft for 1500 ft., and then a still flatter descending grade to the shore shaft, the elevations of the tunnel floor (below datum) being 88.50 at the lake shaft, 78.50 at the summit and 81 at the shore shaft. The tunnel is extended 10 ft. 6 in. west of this shaft, the stub end being used in giving lines and serving also as a chamber for the shaft pump during construction. The same arrangement will be made at the lake shaft. No curved connection is used at the junction of shaft and tunnel.

The borings indicate that below the surface stratum of red clay are hardpan and soapstone, underlaid by a thick bed of brown shale. Thus far (for over 1400 ft.) the tunnel lies in this shale, and it is expected to continue in it for the entire distance.

The shale is hard but shoots easily in blasting, and Fig. 7 shows the character of the excavation. As soon as exposed to the air, however, the material begins to

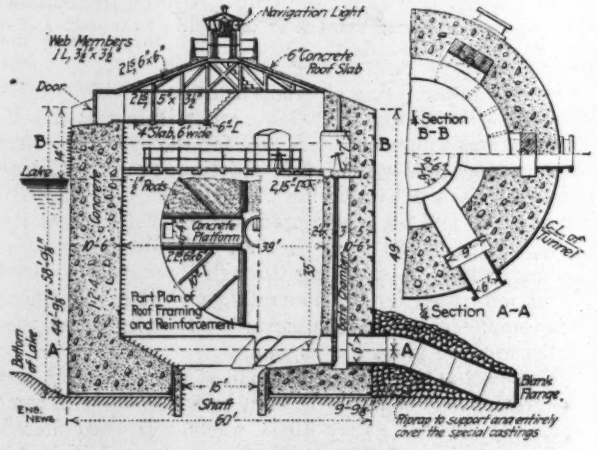



FIG. 5. CRIB AT THE CONNECTION OF THE INTAKE PIPES WITH THE SHAFT OF THE INTAKE TUNNEL; MILWAUKEE, WIS.

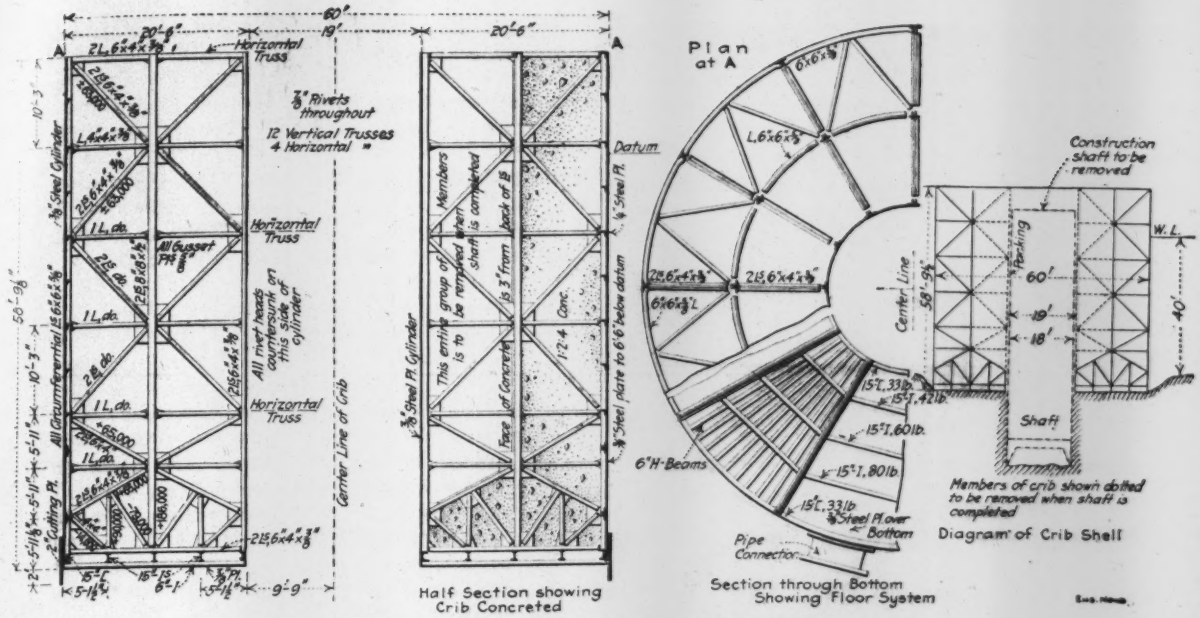



FIG. 6. STEEL SHELL FOR THE INTAKE CRIB

flake and disintegrate, and in contact with water it soon turns to mud. Very little water has been found, and only a few pockets of gravel; some gas has been encountered. A concrete lining with a minimum thickness of 18 in. is used, but should any large flow of water be met (making it difficult to place concrete) a four-ring brick lining will be substituted.

The excavation of the tunnel was commenced on Aug.

FIG. 7. THE HEADING OF THE INTAKE TUNNEL AT MILWAUKEE, WIS.

14, 1913, and the concreting on Oct. 12. Up to Apr. 1, 1914, the heading had progressed 1275 ft. from the shore shaft and the lining had been completed for 1163 ft.

### Tunnel Construction

All material is delivered by wagons at the top of the bluffs, a part of the park being inclosed for the construction camp. It is then lowered by a cable incline to the concrete material bins or the storage space in the fill around the shaft. The compressor plant for the drills

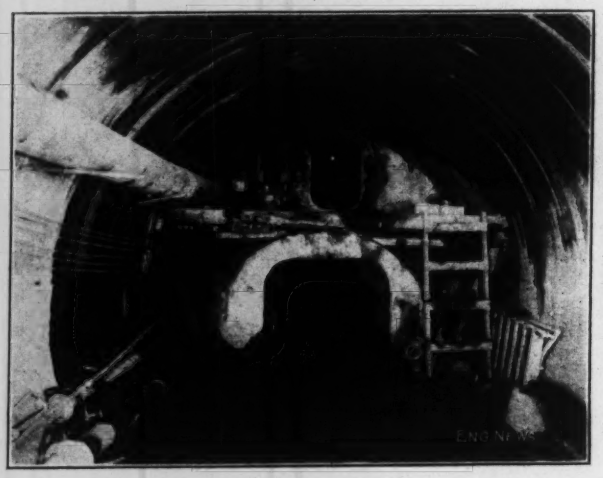


Fig. 8. Air-Lock in the Milwaukee Tunnel

and for the pneumatic pressure system is located on the bluffs. A dynamite store is built on the slope of the ground. On the fill at the lower level are the concrete mixing plant (with a single 1-yd. mixer), the stable, blacksmith shop, etc., and the shaft house. Electric motors are used to operate the compressors, the mixer, the cable hoist and the shaft elevator.

To provide for carrying on the work under compressed air, if water or loose material should be encountered, an air lock has been placed 75 ft. from the shaft and provision made for carrying 35 lb. pressure. So far, however, air pressure (14 lb.) has been used only occasionally, the work being in the solid shale rock, with practically no water. The lock is shown in Fig. 8. The material lock is 7 ft. diameter and 21½ ft. long, with a track for the cars and a door 4x4 ft. Above this is a man lock 4x12 ft., with doors 2x1 ft.

The excavation is carried down to the level of the base of the side walls. These walls are built first and are followed by the roof arch. They are built two or three days ahead of the arch and are kept about 30 ft. in advance of the latter. After the completion of this part of the tunnel, the contractor will work back, excavating the bottom and placing the concrete invert.

Four drills are used. A typical arrangement of the drill holes is shown in Fig. 9, there being 16 holes in the face and two or four vertical holes in the bench. A diagram (similar to Fig. 9) and report of every blast is made by the inspectors, and a typical report (referring to the construction in Fig. 9) is as follows:

Holes A—Blast 3:20 p.m. Key, 6 holes, 6 ft. deep. Bench 2, holes 8 ft. deep. 17 sticks 1½x8½-in. 60% dynamite.

Holes B—Blast 3:45 p.m. Head, 6 holes 4 ft. deep, 12 sticks 60% dynamite, 1½x8½ in.

Holes C—Blast 4 p.m. Head, 4 holes, 4 ft. deep, 4 sticks 60% dynamite, 1½x8½ in.

The muck is hauled out in small steel cars (1 to 2 yd.), which are dumped to form a fill at the head of the shaft, as described already (Fig. 3). Similar cars carry the concrete. Mules are employed for hauling in the tunnel. The limit of free haul is 1000 ft. The roof is supported by 12x12-in. cross timbers, and when the roof breaks considerably beyond the normal line of excavation the space is filled with cribbing, as shown in Fig. 9.

Steel collapsible forms are employed for the lining of the sides and arch, as shown in Figs. 9 and 10. The cars are hauled by a cable (with motor hoist) up an incline to a working platform, and dumped on either side for the walls. For the roof, it is dumped on the platform and shoveled into place. The concrete is a 1:2:4 mixture, using 2-in. broken stone. It is reinforced with ¾-in. longitudinal and transverse bars, using vertical bars in the side walls and curved bars in the arch roof and invert. The use of steel lagging gives a very smooth surface to the concrete, as may be seen by Figs. 8 and 10.

The work is carried on in two 10-hr. shifts. City inspectors are on the work during the entire time, to keep watch of the excavation, measuring and mixing of the concrete, and the placing of the concrete and steel. They check the lines given by the engineers, but are not allowed to give or extend any lines. This at first led to some complaint by the contractor, who claimed that centers and lines were not given promptly enough. He objected also to the system of continuous inspection and

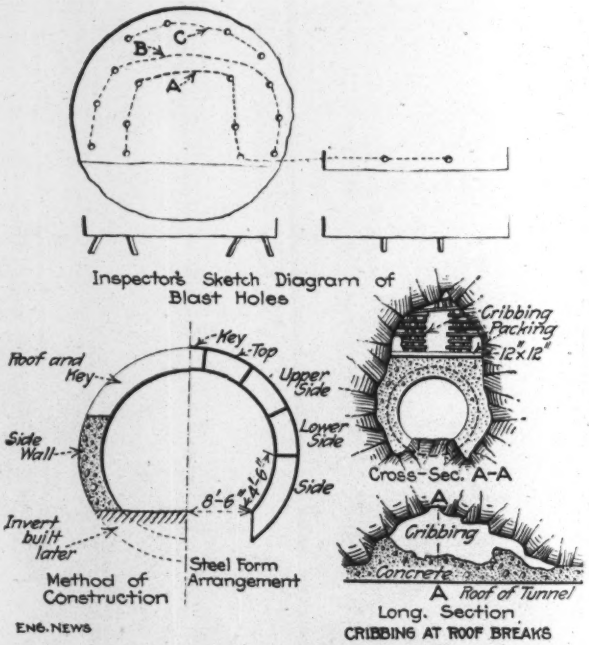
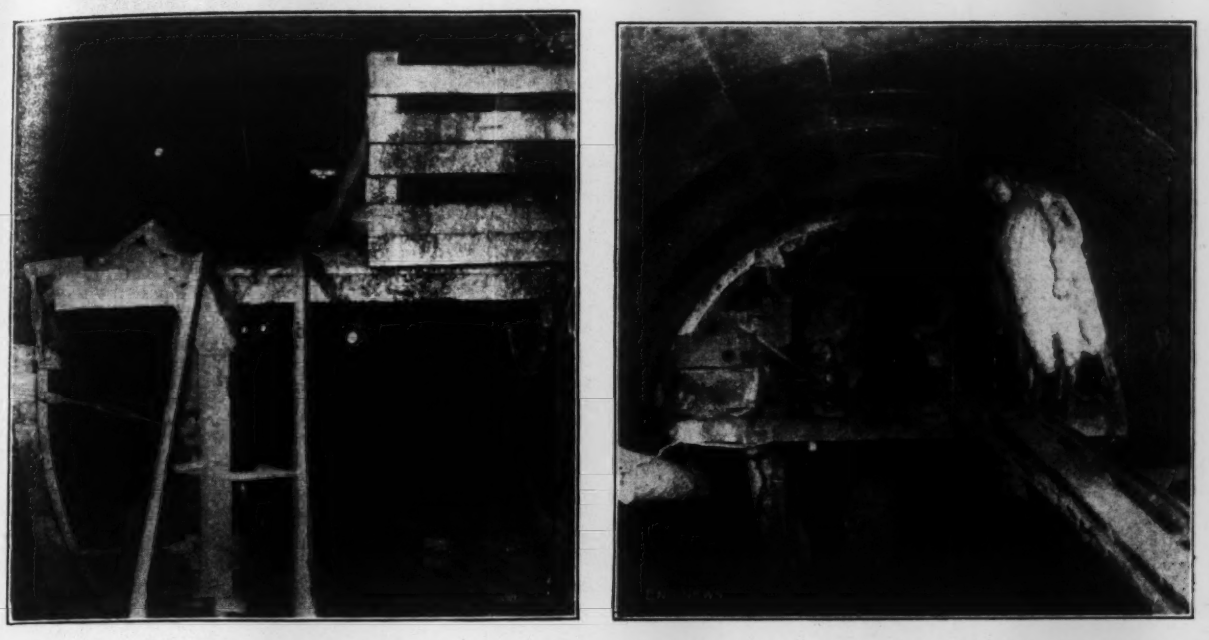



Fig. 9. Features in the Construction of the Milwaukee Tunnel

oversight, until given to understand that it was not for the purpose of harassing him or interfering with him, but simply to insure good work.

### Construction Records

The city engineer having had experience both as an engineer and contractor was well informed as to the



(View of forward end of traveler, with form for side wall in place; looking back from the heading.)

(View of rear end of traveler, with form for roof being placed. At the right is the incline track for concrete cars.)

FIG. 10. STEEL FORMS AND CONCRETING TRAVELER IN THE INTAKE TUNNEL, AT MILWAUKEE, WIS.

necessity and advantage of good records and as to the form of record to be kept. A very complete record is made each day by the chief inspector, using a printed form. This is accompanied by sketch reports of the blasts (Fig. 9) and of large roof breaks, notes of falls (or indications of falls) of rock, water encountered, difficulties with the contractor's men, etc. The report form, shown herewith, is a printed blank 13½x8½ in., and the matter in italics represents the matter written in by the inspector. For item No. 9 (relating to the work of the engineers), typical entries are as follows: "On the job 8 a.m. to noon, on top"; "On job in afternoon, gave center of shaft and checked shaft forms."

Items Nos. 10 and 11 are valuable as records affecting possible future disputes or claims. Thus they show that the contractor was notified not to set shaft forms on a green concrete floor for 24 hr., to mix better concrete, and to arrange some device for regulating the supply of water to each batch of concrete; he was also notified three times to put safety clutches in the elevator cages,

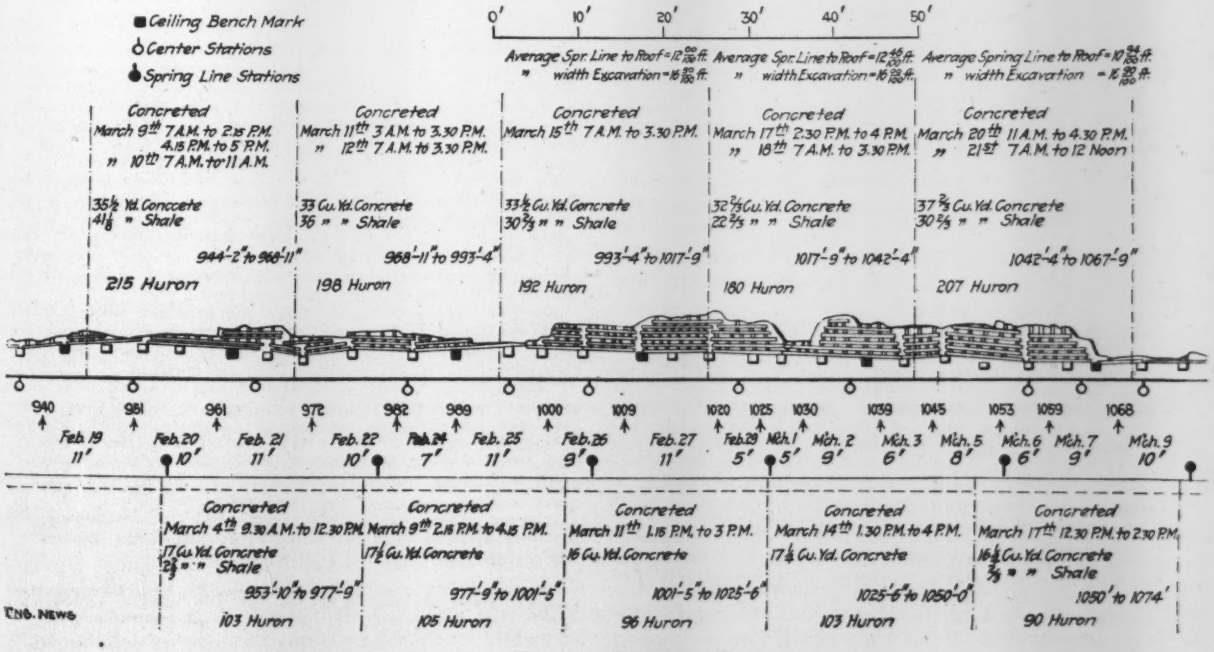

Ceiling Bench Mark
Center Stations
Spring Line Stations
0' 10' 20' 30' 40' 50'
Concreted
March 9th 7 A.M. to 2.15 P.M. 4.15 P.M. to 5 P.M.
" 10th 7 A.M. to 11 A.M.
35½ Yd. Concrete
41⅛ " Shale
944'-2" to 968'-11"
215 Huron
Concreted
March 11th 3 A.M. to 3.30 P.M.
" 12th 7 A.M. to 3.30 P.M.
33 Cu. Yd. Concrete
36 " " Shale
968'-11" to 993'-4"
198 Huron
Concreted
March 15th 7 A.M. to 3.30 P.M.
33⅓ Cu. Yd. Concrete
30⅔ " " Shale
993'-4" to 1017'-9"
192 Huron
Concreted
March 17th 2.30 P.M. to 4 P.M.
" 18th 7 A.M. to 3.30 P.M.
32⅔ Cu. Yd. Concrete
22⅔ " " Shale
1017'-9" to 1042'-4"
180 Huron
Concreted
March 20th 11 A.M. to 4.30 P.M.
" 21st 7 A.M. to 12 Noon
37⅔ Cu. Yd. Concrete
30⅔ " " Shale
1042'-4" to 1067'-9"
207 Huron
940 961 972 982 989 1000 1009 1020 1025 1030 1039 1045 1053 1059 1068
Feb. 19 11' Feb. 20 10' Feb. 21 11' Feb. 22 10' Feb. 24 7' Feb. 25 11' Feb. 26 9' Feb. 27 11' Feb. 29 5' Mch. 1 5' Mch. 2 9' Mch. 3 6' Mch. 5 8' Mch. 6 6' Mch. 7 9' Mch. 9 10'
Concreted
March 4th 9.30 A.M. to 12.30 P.M.
17 Cu. Yd. Concrete
2⅔ " " Shale
953'-10" to 977'-9"
103 Huron
Concreted
March 9th 2.15 P.M. to 4.15 P.M.
17½ Cu. Yd. Concrete
977'-9" to 1001'-5"
105 Huron
Concreted
March 11th 1.15 P.M. to 3 P.M.
16 Cu. Yd. Concrete
1001'-5" to 1025'-6"
96 Huron
Concreted
March 14th 1.30 P.M. to 4 P.M.
17⅛ Cu. Yd. Concrete
1025'-6" to 1050'-0"
103 Huron
Concreted
March 17th 12.30 P.M. to 2.30 P.M.
16⅛ Cu. Yd. Concrete
⅞ " " Shale
1050' to 1074'
90 Huron
ENG. NEWS

FIG. 11. PART OF PROGRESS PROFILE

PROGRESS REPORT ON MILWAUKEE INTAKE TUNNEL

(Italics represent matter written in by inspector)

This report covers period from.....4 *p.m. March* 31 *to* 4 *p.m. April* 1, 1914

Daily Report. No. 276

Linwood Avenue Intake—Milwaukee Water Works, Milwaukee, Wisconsin.

Daily Report must be written by Chief Inspector who will be held responsible for accuracy of daily report and for omissions of facts that office should know. Every one of these sheets must be accounted for. White, pink and yellow sheets to be sent to City Engineer's Office (white for City Engineer, pink for Commissioner of Public Works, and yellow for Superintendent of Water Works). Every spoiled copy must be marked void and sent to office.

Day....*Wednesday* 4 *p.m.* Date....*April* 1, 1914

1. Materials delivered.....*Stone* 20 *cu.yd. Sand* 20 *cu.yd.*
2. Excavation..... *Blast* 3.20 *p.m.*, 3.45 *p.m.*, 4 *p.m. March* 31. *Blast* 2.50 *a.m.*, 3.15 *a.m.*, 3.30 *a.m.*, *April* 1. *Station* 12+75 *Brown shale*
3. Bracing..... *Station* 12+66 *to* 12+70
4. Concrete work..... *Side walls* 11+71 *to* 11+95, 1.40 *p.m. to* 3.30 *p.m.* 14½ *cu.yd.*, 1:2:4; 81 *bags Huron cement*
5. Reinforcement..... 8 *rods E. & W.* = 32 *pieces* 8 *ft. by* ¼ *in.* 22 *arches* = 44 *pieces* 8 *ft. by* ¼ *in. Arch* 11 + 39 *to* 11 + 63; 17 *rods E. & W.*, 68 *pieces* 8 *ft. by* ¼ *in.* 22 *arches* = 114 *pieces* 4 *ft. by* ¼ *in.*
6. Brickwork..... *None*.....
7. Air drills..... *Key*, 12 *holes* 6 *ft. deep. Bench*, 8 *holes* 8 *ft. deep.* ..... *Head*, 18 *holes* 4 *ft. deep*
8. Plant, condition of { Air locks and piping..... *Locks open, piping O. K.* / Air compressors..... *Working order* (3) / Pumps..... *Working O. K.* (3)
9. Engineers giving line and grade... *On job* 8 *a.m. to noon, on top*
10. Orders to contractor for changes or otherwise.... *None*
11. Requests of contractor..... *For engineers tomorrow morning. Have only one center ahead of arch. No bench marks ahead*
12. General progress of work..... *Working two full crews, ten hours each*
13. Miscellaneous..... *Head is dry, material somewhat softer*

| Trade | Rate | No. of men | Total | Kind of work and stage of progress |
|---|---|---|---|---|
| Gen. supt..... | | 1 | | *On tunnel* |
| Night foreman.. | | 1 | | *On tunnel* |
| Sub. foreman... | | 3 | | *On tunnel* |
| Mast. mechanic. | | 1 | | *On plant* |
| Electrician..... | | 1 | | *On plant* |
| Enginemen..... | | 2 | | *On tunnel* |
| Blacksmith..... | | 1 | | *On tunnel* |
| Drillers..... | | 8 | | *On tunnel* |
| Muckers..... | | 40 | | *On tunnel* |
| Laborers ..... | | 15 | | *On tunnel* |

| Job No. | Location | Station | Grade | The above is correct |
|---|---|---|---|---|
| .... | *Tunnel* | 12+75 | | *H. S. Hughes*, Chief Inspector |

| Condition of weather | *April* 1, 1914 | | | | Temperature | | | | *March* 31, 1914 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Cloudy* | Hr. | Deg. | Hr. | Deg. | Hr. | Deg. | Hr. | Deg. | Hr. | Deg. |
| | | 6 a.m. | 38 | Noon | 52 | Midnight | 36 | 6 p.m. | 36 | | |

with intimation that no further notice would be given (but other action taken). On the other hand, the record shows requests from the contractor to have lines given, and to have tests made of certain cements and sands.

The number of men at work each day is shown, but the rates of pay are entered only once (unless changes should be made). These rates (per day) are as follows:

| | | | |
|---|---|---|---|
| Tunnel foremen ..... | $5.00 | Electrician ..... | $3.50 |
| Subforemen ..... | 4.00 | Drillers ..... | 3.50 |
| Master mechanic ..... | 5.00 | Muckers ..... | 3.00 |
| Carpenters ..... | 3.50 | Laborers ..... | 2.50 |
| Blacksmith ..... | 4.00 | | |

Besides the daily written report, there is a progress profile showing the daily work. A separate sheet is used for each month, and a short portion of one sheet is shown in Fig. 11. It gives the average height and width of cut, the length concreted, the time of concreting, the amount of concrete and of shale packing, the amount of cement used, etc. The concrete and cement record for the arch is given above the profile, while that for the side walls is given below it.

**A Large Central Heating Plant**—About 22,000 tons of coal is the annual consumption of the central heating plant of the University of Wisconsin, at Madison, Wis. Only 10% of the total fuel is chargeable to power uses. All power exhaust, together with low-pressure live steam, is used for heating. At present 42 buildings are heated from the central plant, including practically all of the University buildings and the U. S. Forest Products Laboratory. The distribution system includes 2 mi. of tunnel and 1 mi. of conduit. The maximum pipe size is 16 in.; on this a total thickness of 3 in. of 85% magnesia insulation is used. The heating pressure is 5 to 10 lb., and no difficulty in maintaining pressure at the receiving end has been experienced. The plant is about six years old, replacing an earlier central heating plant which became obsolete as to capacity and location of station.

# The Economics of Safet

Society as a whole is only justified in expending f safety an amount which that safety will produce or conse To make the conditions of life as safe as science has sh possible, without regard to the productive value of suc afety, places upon society a burden it cannot bear ind itely. Safety must be paid for out of income. Otherwise y spend your principal and exhaust your resources.

In all the hazards of life, we must assume reasona care to be exercised. If we did not assume reasonable we would never transport dynamite. Absolute safety is not necessary; safety, with reasonable care, should be the supreme aim.

On the Pennsylvania Railroad, during the six months from July 1, 1912, to January 1, 1913, there were 7400 injuries to employees, of which 139 resulted fatally. Careful analysis showed that all but 10% would have been avoided by reasonable care on the part of the men.

In England, where life is highly valued, the railroads use wooden passenger cars, veritable bandboxes. The reason for not replacing them with steel is frankly given as the great cost. In this country we have gone far ahead of England in this respect. We are building steel cars as fast as practicable. But to equip all our companies with steel cars immediately would cost $600,000,000 and the railroad companies could not pay the bill.

Suppose we apply the principle of insuring absolute safety to our ordinary daily life. We hear frequently of families burned to death in their homes. Do we immediately order all landlords to build houses that shall be fireproof?

There remain on the 11,000 miles of line comprising the Pennsylvania System, 13,027 crossings at grade. To eliminate them all would cost upward of $600,000,000. To remove all grade crossings in the United States would cost over $5,000,000,000.

It is desirable to remove grade crossings as rapidly as possible. The Pennsylvania System has spent about $75,000,000 the past ten years in improvements involving the removal of grade crossings but the continuance of the process will of necessity be slow, and if people will only "Stop, look and listen" as they come to a railroad grade crossing, a large part of this awful waste of human blood will be prevented.

The Interstate Commerce Commission and others have frequently urged the railroads to adopt an automatic stop. No automatic stop has yet appeared which will give proper service; but assuming the invention of a reliable automatic stop, would its use be desirable? At present the responsibility for the safety of a train is concentrated in the men of the engine crew, whose own lives are at stake. An automatic stop would transfer this responsibility to the man who sets the signals, whose life is not at stake. England has had more serious accidents of late from man failure in the signal tower than man failure in the engine cab. It is to the man that we must look in the final analysis.

These same principles apply to the safety of locomotives and those using them, a subject to which the government is giving much attention. Our own companies have been compelled to expend over $600,000 in installing self-cleaning ash pans—an expense, in our judgment, absolutely wasted.

It is now proposed to establish an arbitrary allowable stress for locomotive boilers—a factor of safety, as it is called. A factor of safety must always be a matter of judgment, but that judgment should not be merely an idea but should be a result of the best practical experience.

The experience of American railroads is that only 6 boiler shells, out of 63,000, have exploded during the last two years. Yet it is now proposed to impose a very heavy burden of expense upon railroad companies to make their boilers still more immune from accident.

On the Pennsylvania Railroad there hasn't been a boiler-shell explosion since 1880. Yet if the new plan is put into effect we must, at considerable expense, decrease the allowable stress on boilers in about 5000 locomotives.

We can only go by experience in such matters. It is an economic waste to put more weight in a bridge than allowance for its expected burden and any reasonable increase of weight requires. So it is with a locomotive. What is needed is careful workmanship in the beginning, careful maintenance and careful handling. It is the man that we must look to, not rules and mechanical formulas.

Let us concentrate on the man. Not in rules or mechanics will we find half the safety we will in the fidelity and the enthusiastic service of conscientious men.

*Extracts from an address by Ivy L. Lee, Executive Assistant, Pennsylvania R.R. Co., at the eighth annual convention of the Master Boiler Makers' Association, Philadelphia, May 25, 1914.

# Editorials

## The Latest Suggestion for Sewage Disposal for New York City

One of the latest of many recent plans for sewage disposal at New York City is reported in one of the dailies as, first of all, "conveyance in *tubs* [italics ours] to Sandy Hook." A bit further on the reader finds that for "tubs" he should read "tubes," but he is left to place his own interpretation upon the statement that the tubes would be laid "at a depth of about 55 ft. to avoid *impending* navigation [italics again ours]. Assuming that the "tubs" of sewage are successful in avoiding "impending navigation" and get safely to Sandy Hook the plan of disposal proposed is "sand filtration," which would convert it [the sewage] into pure water before its discharge into the ocean." We hardly need add that a proposition to convert the sewage of 5,000,000 people into "pure water" by "sand filtration" is only in degree less absurd than to convey it to Sandy Hook in "tubs."

## Eliminating the Accident Hazard of Electric House Circuits

We have noted from time to time some of the more conspicuous cases of accidental death from touching common electric-light fixtures where the low-voltage (alternating-current) circuit had become connected to the corresponding and necessary high-tension supply lines through punctured transformer insulation or other fault. In our issue of May 9, 1912, we showed the gravity of the danger and called attention to the very simple and effective means of protection available (connection of house circuits to earth), and advised the hearty coöperation of water-works officials, both public and private—for water lines give the only sure earth connection.

The progress made in this safety movement has not been very gratifying—if we interpret aright the figures in a recent committee report to the National Electric Light Association. This is in spite of mandatory action of electrical and insurance bodies and at least one state utility commission (New Jersey). The committee mentioned obtained data from 575 electricity-supply companies (out of some 5000 such in the country). Only 325 are known to be grounding their secondary circuits but this includes all the large utility corporations supplying alternating current. Only 222 concerns are allowed to ground their wires on water pipes (131 municipal departments, 83 private companies and eight works not identified giving such permission). Worse still, only 112 make use of that permission.

In the interest of greater safety in domestic electric service, which has become one of our greatest utilities, we cannot refrain at this time from again drawing the attention of municipal officials and engineers generally to the need of completing this work and to the universal benefit of securing more coöperation between the water-works and electric-light men. All can be assured of the reality of the protection offered and of the impossibility of electrolytic destruction of pipes from the momentary alternating currents that may come upon them.

We hope the time may hasten when such reports as mentioned will show all alternating-current supply companies so grounding their lines and all these concerns using water-pipe connections. *Prima facie* evidence of criminal negligence is exhibited where this grounding can be done but is not. A few instances of severe court punishment would go a long way to hurry the better conditions.

## Some Noteworthy Points about the Connecticut State Highway Department

We recommend a perusal of the article on another page of this issue, describing the organization and work of the Connecticut Highway Department, to every engineer who is the head of an engineering organization. It will prove of almost equal interest to engineers who are but the lesser parts of such organizations. The article gives clearly and succinctly some of the means of introducing the human element into a public-works organization.

The State Highway Commissioner of Connecticut, Charles J. Bennett, a civil engineer and technical graduate, has publicly stated that his greatest difficulty with engineering assistants is to find engineers with a proper appreciation of the business elements involved. Why does this condition exist? Possibly because most engineers are outside employees (literally and figuratively both) and are seldom taken into confidence by those who manage the business end.

Mr. Bennett has hit upon a plan of making his assistants his partners in a great public enterprise. There are no secrets in his organization, consequently there is mutual confidence. His assistants are kept informed on all matters relating to accounting and settlements with contractors, as well as on matters pertaining solely to engineering.

Another admirable point is the Commissioner's scheme of furnishing the division engineers with copies of all such of his correspondence as relates to them or their work. . If a contractor is attempting to register a private knock at an engineer, or is attempting to pull wires over an engineer's head, that engineer knows that he will have the facts first hand; he is not left to surmise and draw distorted and erroneous conclusions from his suspicions. If fault-finding is done, it is done with the knowledge and consideration that the fault-finder is face to face with the one of whom he complains.

Under such an organization, it is easy to believe that a spirit of fair play and justice and mutual forbearance soon governs the minor subordinates as well as the chief and his immediate assistants. Mutual confidence means *esprit de corps*; and *esprit de corps* in a public-works engineering organization spells *efficiency*.

## Multiple and Overlapping Inspections

Municipal and state inspections of one kind and another are essential in this particular stage of social and governmental evolution. It is not essential, though perhaps for the present it is almost inevitable, that the number of inspecting bodies should be so numerous and annoying as they are. Thus Marcus M. Marks, Borough President of Manhattan, said in a recent address:

> I find that in New York City at least seven departments can send inspectors to a citizen's house or building. These are: (1) The Bureau of Buildings, (2) the Fire Prevention Bureau, (3) the Fire Department, (4) the Health Department, (5) the Tenement House Department, (6) the Department of Water Supply, Gas and Electricity, and (7) the License Bureau. Add to this the State Labor inspection and we have a total of eight legal inspections which can be made. In addition to this, each one of these inspectors has the right to lay down rules and instructions as to what shall or must be done to comply with the law, as his department sees it.

The New York *Post*, of May 25, made this quotation a text for an editorial on "The Over-Regulation of Buildings." It is not so much a matter of over-regulation as of too numerous regulating bodies, whose functions and activities overlap. This appears to have been recognized by Mr. Marks, who suggested a "joint board of inspection," in place of many boards whose demands are often in conflict. The suggestion is worthy of consideration, and as regards state as well as municipal boards. As we have previously pointed out, there is now considerable overlapping of jurisdiction in some of our states. To repeat our former illustration: Water-works plants in New York State are under some degree of control by the Department of Health, the Conservation Commission and the Public Service Commission. Such a condition as this in the state at large and, as Mr. Marks outlines, in New York City, is not only a source of needless annoyance to individuals but also of needless expense to the state and the city.

## Shall Cost or Value of Public-Utility Service Be the Basis of Rates?

At the recent convention of the National Electric Light Association, representing the larger part of one of the greatest utility industries, a "Committee on Rate Research," which has been studying rate questions for several years, brought forward a proposal that, after the overall rate of a utility company had been fixed (as "reasonable return on fair value") the "detailed rates," better called the "tariffs," should be arranged by considering the value of the service to the buyer and the seller. Some important general discussions from this report are reprinted elsewhere in this issue; they will be found interesting as an outline of the elements entering into value of service, though they will not be readily accepted as the new basis of making tariffs thus described by the committee:

> When the rates as a whole are giving a fair return on the investment, then the rates to separate individuals and classes which go to make up rates as a whole, should be so adjusted as to make the total as low as possible and the service rendered as great as possible by means of the most effective utilization of plant. These results can best be obtained by adjusting the various rates to the value of the service rendered, giving proper consideration also to the relative costs of service and defining value of service as the amount which the user would have to pay for the same or equivalent service under absolutely fair but not destructive competition.

Now it will be admitted that the adjustment of tariffs in railroad transportation is necessarily dependent on many things besides cost of service. The number of kinds of service is so great and the conditions under which service is rendered are so complex that no other status can prevail. But when we go to other utilities, where complexity obtains to no such degree, the proposition of this committee, that value of service is the measure by which commissions and managers are adjusting (though perhaps unconsciously) and should adjust rates, has a strange sound. Our impressions, after continual study of the important cases that have arisen in these years during which regulation has been developing, is that more and more "cost-of-service" is taken as the starting point even in the adjustment of tariffs, and is adhered to so far as possible; although when the data for this basis fall short, recourse is had to "value of service" as a necessary substitute for any further subdivision needed. In many cases, the value of a service rises or falls with the true cost of the service and therefore many tariffs that really have been adjusted between classes of customers according to cost basis respond to the tests of value as set forth by the committee in question.

There is, first of all, one thought to be considered in comparing a "value-of-service" with a "cost-of-service" basis, and this explains the popularity of cost criteria. The committee defines "value of service" as an "amount which a user would have to pay for the same or equivalent service under fair but not destructive competition." When our industrial life was more simple and competition was more free, the selling price of a manufactured product and the production cost were very nearly parallel year after year. When virtual monopoly intervened, the manifest desire of the people was to continue, nevertheless, the condition with which they had so long been familiar. This desire to regulate monopolies then manifests itself, in one important way, by attempts to keep production cost and selling price still parallel and separated at all times only by profits no larger than obtained with similar risk and similar attention to investments in other lines of manufacturing effort. This idea antedates utilities as at present constituted and is the application of the general treatment popularly desired for monopolistic business. Apparently then, there is a more or less of a national demand that "cost of service" as a basis of rates be adhered to as far as possible.

Aside from that, however, "cost of service" is a great convenience in the detailed adjustment of utility rates and exhibits a directness and tangibility in marked contrast with value of service for this purpose. The actual process of adjustment as carried out by the value-of-service tests is necessarily a more empirical one—one that requires better judgment and greater experience on the part of the adjusters since there must be a scarcity of definite figures for change in value from one person to another, from one class to others, from this hour to that or from this season to that.

It is easier to approximate reasonably the cost of serving this or that customer in very many cases than to quantitatively fix value or service to each, for in the former case there are wholly tangible and definite data to start off with. It requires good judgment still, but the adjusters are anchored to a considerable extent. The re-

port in question shows how the values may vary in general, but it is evident that the application of these general principles to specific cases calls for a high degree of skill, a complete knowledge of local industrial and social conditions and, with these, rare good judgment. These form a combination too much to expect in a very large number of cases. If it be a state commission making these adjustments, the geographical breadth of its work may prevent the desirable intimate knowledge of local matters though the members of the commission may have skill and judgment. Local municipal commissions can be no more successful because of other limitations.

We concede that corporation officials charged with the adjustment of rates might, after a long study, be willing to place before the public a schedule fixed in accordance with their judgment of local values to different customers. It seems more likely, however, that from the start they would very much prefer to seek public approval of a schedule built up primarily upon the cost books of the company. No doubt there would be a close relation in most cases between relative costs and relative values, could the latter really be discovered. However, under examination, the officials would feel that they stood on *terra firma* and could advance something stronger than judgment in justification of each rate.

It is illuminating to set forth very briefly a procedure by the "cost-of-service" method to show its immediate definiteness as compared with the broad and necessarily vague instructions which would have to be issued in weighing values according to the report reprinted elsewhere.

Preliminary to this, however, it must be remarked that it may be manifestly unfair to make a utility concern compute a different base rate for each customer. Moreover, common public knowledge of the bases for prices might become difficult and unreliable. Public confidence in the existence of an equitable rate schedule might vanish. It would seem as though substantial justice would be done if a customer received a rate that would apply to an "average" customer in a class having similar wants—even though the true unit cost for each customer varied somewhat from all the others, depending on the size of his demand, on his times of service, on his distance from the supply center, etc. In making these classes, the natural commercial separations often suffice. Class separation may exist through sliding scales and increasing discounts, and not be appreciated by the customers. In connection with such classes, or distinct from them, there may be further separation according to time of service relative to peak-load hours, continuity of supply, etc.

Suppose that the company books have yielded first of all the detailed figures of true incomes, expenses, reserves, peak loads and outputs. The various cost data can be grouped for convenient use under "fixed," "operating" and "customer" charges.

*"Fixed charges"* would wholly or largely be allocated according to participation in peak-load demands, except in special circumstances, and would include: (1) return on agreed value; (2) rentals; (3) part of allowances for obsolescence; (4) taxes; (5) insurance; (6) part of salaries of administrative officers and clerks; (7) part of general office expense; (8) part of engineering office expense; (9) part of profit over and above common interest return on agreed value.

*"Operating charges"* would be distributed according to quantity of service rendered, and would include (1) appropriations to reserve against lean years, etc.; (2) part of annual obsolescence allowance; (3) part of salaries of administrative officers and clerks; (4) part of general office expenses; (5) part of engineering department expenses; (6) operating labor; (7) operating supplies; (8) cost of repairs; (9) depreciation-fund appropriations; (10) amortization appropriation; (11) interest on working funds; (12) cost of leaks and losses; (13) bad accounts; (14) accident-liability insurance or equivalent; (15) appropriations for welfare work, charities, etc.; (16) advertising.

*"Customer charges"* would be allocated on individual customers and would comprise: (1) cost of meter reading; (2) cost of accounting, billing and collecting departments; (3) a small part of the salaries of administrative officers and clerks; (4) a small part of general office expenses.

Many will not wholly agree with this separation of accounts and its justification in detail will not be taken up here, as it is not exactly pertinent to a comparison of the vagueness of a "value-of-service" procedure and the definiteness of one following "cost of service." The point is that this or some modified schedule can be made which the tariff adjuster can follow easier than he can weigh values.

The total cost for a given class can be found from the company accounts, as noted, and this, divided by the output to the class, gives the average price on unit output for the class or the tariff for members therein. It will be argued that some of the expense items divided into three parts can be so distributed only with arbitrary assumption of relative cost. It will be claimed that there is no very accurate data as to the participation of individuals and classes in peak loads. Admittedly in following a cost-of-service basis as closely as possible, complete mathematical accuracy is out of question; judgment must still be used and the division of items must be influenced by opinion.

However, the debatable items would not form probably more than 25% of the total under each part of the basis for any class rate. If the estimates were 50% off (that is over or under by 100% of the undiscoverable actual figure of the moment) then the discrepancy in rate basis would probably not be more than 10% to 15% for any one of the three parts. The departures from the undiscoverable and unstable actual cost figure may be plus or minus, and the probabilities are against cumulative effect on any one class of consumers. Errors of judgment would tend to balance each other; variations in individual service would change a plus to a minus departure. The variation of individual requirements from their class average would be unstable and of the same order of magnitude and the whole cost-apportionment process has license to be only as accurate as the fundamental assumptions.

Indeed that hypothetical thing called "real cost" may vary with the point of view. The result of the cost apportionment under the three heads of fixed, operating and customer charges is that one or a few classes of customers in some utilities may carry nearly all the investment charges since they may cause practically all the peak load. For instance, some men regard the entire capacity of an electric generating station as reserved to care for the lighting and railway customers at some particular

hour and season while the other bits of business have been worked up to use idle plant. Such customers have been secured probably only through having to bear no considerable share of the investment charges. Yet there in an element of equity in the argument that if the whole peak-load capacity is not in reserve all of the time (while it is serving the off-hour business picked up) then it is not quite fair to charge all of the investment on the maximum-peak customers for whom complete reservation is not being made at some hours. Here lies the great utility of the value-of-service theory in deciding how much of the fixed charges can be borne by the nonpeak consumers.

It is a plausible argument that the profits to be made on off-peak customers may rightfully be "what the traffic will bear" rather than "fair return on value of property required," since this fair return is already assessed on others. A concern which has worked up a good nonpeak business may be justified in asking approval of a net earning greater than the "fair return on fair value," the excess coming from the purely cultivated trade. This would give desired stimulus for progress. Yet wise company policy perhaps would dictate throwing some of the investment charges from the true utility customer to the competitive trade, to distribute more widely the benefits of improved load conditions.

Simplicity in a rate schedule, built up as noted on a cost-of-service basis, depends on inherent simplicity of the business. If the customer's characteristics are all alike, then but one class and one form are necessary for the charge. Sometimes several classes or a two-part basis appears more advantageous; with greater complications comes the use of many classes or three factors in computing each customer's bill. Whatever form is given to the results of a cost-of-service tariff adjustment, those responsible for it rest easy in their ability to display tangible fundamental data, to demonstrate operations of an accuracy consistent with that of the data, and yet to give proper consideration to the play of economic values.

# Letters to the Editor

## A Curious Chapter in Bridge History

Sir—In going over some of my great-grandfather's papers in Maryland a short time ago, I found one, a letter that I am sure will interest some of your older readers, and will satisfy them that they are right in suspecting that the self-satisfied constructor of the present day is not the first man with original and creative ideas.

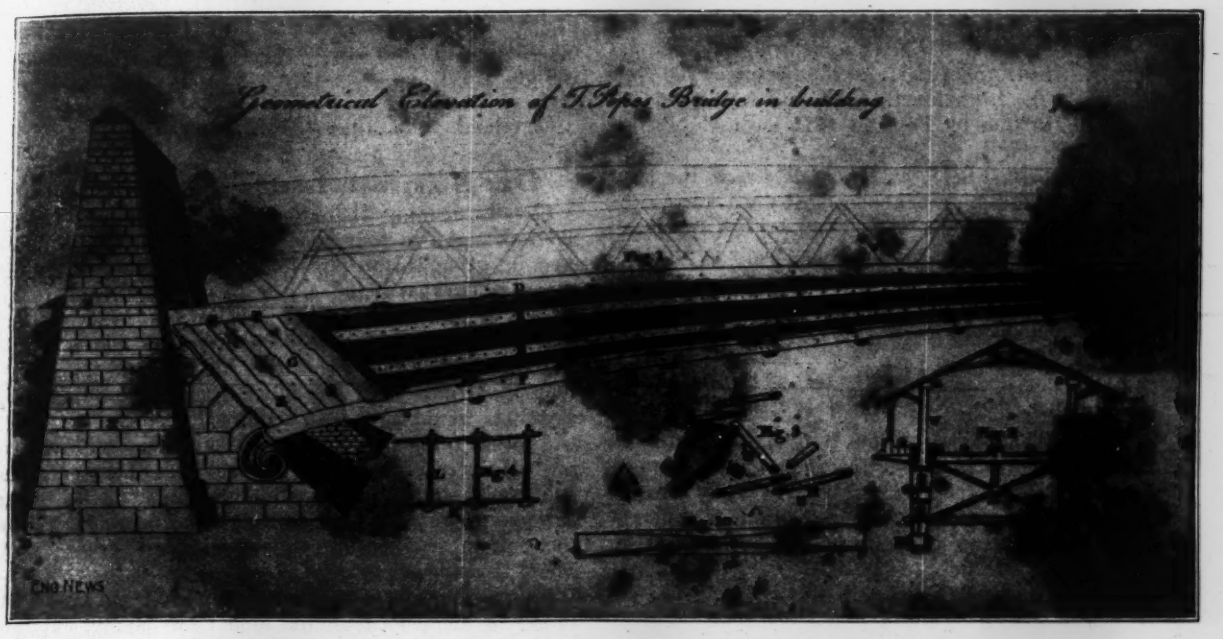
The letter is addressed to:

John Stump, Esq.,
within Six miles of Havre de Grace,
Susquehanna.*

*The name Susquehanna seems to have been intended as the equivalent of Maryland.

Let the Broad Arch the spacious Hudson stride
And span Columbias Rivers far more wide
Convince the World America begins
To foster Arts the ancient work of Kings
ENG. NEWS

FIG. 1. REPRODUCTION OF THOS. POPE'S DESIGN FOR A BRIDGE ACROSS THE HUDSON RIVER IN 1811.




A—Fulcrum, on which point the bridge would pivot, where abutment of less weight than projecting arm.
B—Bar or beam-abutment counterbalancing arm.
C—Arm of bridge.
D—Cap plates for top of each rib, composed of secondary pieces of timber spliced and tabled together, and are of such magnitude as extent of bridge may require.
E—Horizontal levers, which are termed longitudinal needles.
F—Archivolt (or soffit) rails, which are placed at the bottom edge of each rib, spliced and tabled like the cap-plates at D.
G—Angular levers or voussoirs, perpendicular logs framed in bents or pairs, as they support and inclose the longitudinal levers by resting in each other as their end grain tusk, cut outof solid timber.
H—Iron chain bands to fasten angular levers together.
I—End grain resting plates of the angular levers, on which the chain bands are fastened.
K—Chain plates intended for screw bolts, that may, in some cases be used instead of the above chain bands and keys, or where the said chain bands do not suit, such as for cap-plates and archivolt-rails.
L—Screw bolts and nuts, chain plates and bolts that pass through angular levers may be taken out and locust trunnels inserted in their place, when the two arms of the bridge are united in the center.
M—Rear buttress ties, to prevent arm lifting off buttress.
N—Deck beams.
O—Carriage drives wheels to run on iron skid to save deck.
P—Carriage fender.
Q—Foot paths.
VVV—Stanchions that may or may not be added.
W—Archivolt span beams.
X—Transom braces.
Z—Stone obelisk for an abutment, in the interior of which are sundry timbers and bars of iron, to connect and tie the whole together.

FIG. 2. DETAILS OF THOS. POPE'S "FLYING PENDANT BRIDGE," REPRODUCED FROM AN OLD WOODCUT

The letter reads as follows:

New York, July 24, 1809.

Sir—Some time since I read an advertisement informing that certain persons were incorporated for the purpose of erecting a bridge across the Susquehanna. Since that period sundry persons acquainted with that circumstance having examined my patent invention for bridges have expressed themselves fully satisfied that my kind of bridge alone was suitable to that situation. Commodore Rogers, Esq., of the United States Frigate "Constitution," with several gentlemen of the first celebrity in science, having examined a grand model of a bridge on my plan, with a single arch of 1800 ft. cord, suitable to the East River, New York, have desired that I inform you that he is perfectly satisfied that it is superior in every sense of the word to all others heretofore known, and request that I lose no time in writing you on the subject. Commodore Rogers proposing this day to get under way for a short cruise, prevents his letter accompanying these lines, but means to drop you a line as soon as he returns.

The nature of my invention is as follows:

First, all bridges on my plan are built with a single arch of any altitude required, consequently without piers. Secondly, they are built without center or support of any kind while building; therefore, having nothing to do with the river below. Thirdly, they are of greater duration than other bridges ever built with timber. Fourthly, when they come to decay, they are more easily repaired than any formation of timber ever known. Fifthly, they are built for less money in proportion than any other bridge already executed. Sixthly, the shape of my bridge is sufficient security against the effects of wind and tempest, which in exposed situations is a circumstance of no small importance.

The principle of this invention is founded on the compound lever. The simplicity and yet security of which has very much astonished mathematicians of the first celebrity.

If sir. it is the wish of the parties concerned to erect a bridge which shall afford them a good speculation, it is easy proved that none can equal this that I have the honor to claim. The within design of a half bridge may give you as an outline some small conception of the appearance and grandeur an arm of arch on my patent plan affords; besides the security against ice or other threatening commodities. Will feel obliged by your line of communication at the earliest period convenient in reply to the above, as by the encouragement I may receive from parties concerned, I intend waiting upon them personally to examine the site.

I am Sir
Your obedient & humble servant.
Thos. Pope
Architect and Landscape
Gardener,
30 Wall Street or 412 Greenwich St.

In the New York City business directory of that period, I found that Pope had an office in Wall Street, as indicated in his letter at as early a date as 1807, and that he continued there until 1820. He changed his title, however, once or twice from Architect and Landscape Gardner, to Architect and Surveyor, and to Architect and Civil Engineer.

In Wilson's history of New York, referring to the Brooklyn bridge, the following statement is made:

It should be noted that the elder Roebling had suggested a plan for an East River bridge as early as 1857—similar in lines to the one finally built, and that nearly half a century before, in 1811, one Thomas Pope an architect, proposed to build between the two cities, what he called a flying pendant lever bridge with single span of 1800 ft., etc.

This is evidently the design that Pope had in mind when he wrote Stump in 1809, and which was not recom-

mended to New York and Brooklyn until two years later. It was in brief a timber arch bridge. [The accompanying illustrations are from the Report of the New York City Bridge Department, 1912, and are reproduced from a book written by Pope in 1811 entitled "Bridge Architecture."—ED.]

The Susquehanna River at Havre de Grace, the head of the Chesapeake Bay, was not bridged until during the Civil War, when a single-track wood bridge was built, which later was replaced on the same piers by an iron superstructure. A few years since this was converted into a highway bridge, the Pennsylvania railroad having built a new double-track steel bridge within a few rods of the original structure.

C. NEILSON.

676 Riverside Drive, New York City, Apr. 6, 1914.

[The full title of Pope's curious book is "A Treatise on Bridge Architecture in which the Superior Advantages of the Flying Pendant Lever Bridge Are Fully Proved, with an historical account and description of different bridges erected in various parts of the world from an early period down to the present time.

Exulting science now disdains
The ties of custom's proud controul,
And breaks the rude and barbarous chains
That fetter'd down the free-born soul."

The book winds up with more original poetry, about six pages, desciptive of the proposed bridge and the wonders it is to accomplish. The following couplet is typical:

"Delineate the plan by simple rules
That those who can't believe may prove they're fools."

The explanations of the illustrations are taken from this book.—ED.]

## Tributes to the Late Alfred Noble

Sir—In the proposal to do honor to Alfred Noble, permit me to add my tribute to those of Messrs. Cooper and Duryea. My personal relations with Mr. Noble were not so close nor of such long standing as those of Mr. Duryea; but from a different point of view I can warmly endorse the praise which has been given.

From my first work in 1887 till the present day, Mr. Noble has been an ideal. His picture hangs above my desk. His name is revered in my home and my friends have been his friends.

At first my knowledge of this great man came to me, filtering through the gossip of multitudes of workmen and engineers. Sandhogs and bridgemen, everywhere knew Alfred Noble and the customary way of sizing me up was, "Do you know Mr. Noble?" That I did not, seemed a real misfortune, and when in 1897, an opportunity came to work under his direction my satisfaction was supreme.

Today when engineers grow pessimistic about the profession, I wonder where else I could have met Mr. Noble, or shared the richness of inspiration and support which radiated like golden sunbeams from his presence.

Mr. Duryea speaks with authority. The workmen believed him to be the apple of Mr. Noble's eye. But in whatever way we now may honor his memory, his greatest glory and one most in accord with his own modest life, is the stimulation given by his example for the highest standards of life and work. He has glorified our profession.

ALBERT J. HIMES.

Cleveland, Ohio, June 2, 1914.

## On Submarine Pipe-Laying

Sir—In reading the intensely interesting article by T. H. Vaughn in your issue of May 14, on the laying of an 8-in. wrought-iron pipe for submarine purposes, it occurred to me that if the end of his cable had led through a block or sheave planted out ahead of his "heavy guides" that the pull would have been direct no matter which way the wind or tide was setting his tug; and much friction would have been prevented. In fact, no guide posts or rollers would have been required.

Another thing that I have had to contend with in laying pipe across streams is the fact that the pipe bends and breaks at the joints; sometimes in lowering to the bottom, and at other times they break after it reaches the bottom, on account of the different grades upon which the pipe has to rest.

To overcome these breaks at the joint I use pipe 2 in. larger in diameter than the pipe I am laying, cut into lengths from 4 to 5 ft. These pieces I slip over the joints and drive wooden plugs into the ends to keep them in place; and I have no more trouble with bending or breaking at the joints.

J. H. CRUGER.

426 Washington St., Cape May City, N. J.,
May 18, 1914.

[As the method used to haul out the pipeline was to attach the cable to the outer end of the pipe, the block or sheave proposed by Mr. Cruger must either have been placed some 5000 ft. from shore or else moved continually.—ED.]

## NOTES AND QUERIES

**Our attention has been called to a typographical error in the article on "Special Cases of Fixed End Beams" in the issue of May 28, 1914, p. 1196. The final formula,**

$$m_1 = \frac{w\,(1-a)^2\,(2\,l+3\,a)}{l^2}$$

**should have had a 60 in the denominator, and therefore should have read,**

$$m_1 = \frac{w\,(1-a)^2\,(2\,l+3\,a)}{60\,l^2}$$

**as is apparent to anyone who performed the integration.**

**Chemical Power Transmission** was described by E. F. Roeber, President of the American Chemical Society, in an address before that Society on April 16. Mr. Roeber says that by the processes of electro-chemistry it becomes possible to store, as chemical energy the power of a waterfall too remote from industrial centers to profitably transmit its power by electricity. By using the power of the waterfall to manufacture calcium carbide or for the fixation of atmospheric nitrogen or the production of aluminum, the energy produced by the power is put in such compact and portable form that it can be carried to where it can be sold at a profit. Mr. Rieber says:

"Why was fixation of atmospheric nitrogen a failure at Niagara Falls and why is it a success in Norway? Not primarily on account of the process, because the Bradley-Lovejoy process worked with about the same technical efficiency as the Birkeland-Eyde process, though the apparatus was considerably more complicated. No, the decisive element which caused failure at Niagara Falls and success in Norway is the cost of electric power, which is three to five times lower in Norway than at Niagara Falls."

# Transverse Fissures as the Cause of Rail Fractures: Report on Accident at Westerly, R. I.

On Oct. 25, 1913, a passenger train of the New York, New Haven & Hartford R.R. was derailed near Westerly, R. I. (as noted in ENGINEERING NEWS, Oct. 30, p. 891). A report on the cause has recently been made by H. W. Belnap, Chief Inspector of Safety Appliances, Interstate Commerce Commission, and J. E. Howard, Engineer-Psysicist. From Mr. Belnap's report, it appears that the derailed train comprised three Pullmans (steel underframes), one smoker and three coaches (wooden construction) besides the locomotive. The speed at the time of accident was estimated to have been between 30 and 35 miles per hour. The report continues:

Neither the engine nor the tender were derailed. With the exception of one wheel on the north rail, all of the wheels under the first Pullman car were derailed, while all the other cars in the train were derailed and came to rest on the south side of the track, some of them extending partly over the embankment.

The train broke in two between the second and third cars, the four rear cars being separated from the forward portion of the train a distance of about 150 ft.

This part of the New York, New Haven & Hartford R.R. is a double-track line, and trains are operated under the controlled-manual block-signal system. Approaching the point of derailment from the west there are about 2000 ft. of tangent, all on a descending grade of about ½%. The track is laid with 100-lb. steel rails, 33 ft. in length, single spiked to 18 or 19 untreated chestnut, oak, and pine ties, no tie-plates being used on straight track. At the point of derailment the track is on a 12-ft. fill, chiefly composed of gravel. The ballast is of gravel varying from 12 to 16 in. depth. Examination showed this track to be in good condition. It was raining at the time of the derailment.

Examination of the equipment of the derailed train showed nothing which in any way could have contributed to the derailment. Examination of the track showed that the first indication of anything wrong was a broken rail on the south side of the track. West of this broken rail there were no marks of any kind upon the rails or ties, while east of the same the ties had been cut and broken by derailed wheels, the track being torn up for a distance of about 600 ft. East of the initial point of derailment the north rail was torn out of alignment for a distance of about 12 rail lengths, while 12 successive rails on the south side were also torn up. Four of these rails on the south side were separated from each other, the bolts at the rail joints having been sheared off.

Mr. Howard's report shows that the broken rail causing the accident was of openhearth steel, 100-lb. section, made by the Bethlehem Steel Co., in April, 1910. The height was 6 in., head width 2⅝ in., base width 5½ in., web thickness ⅝ in., length 33 ft., moment of inertia 47.18. The head had retained its shape and there was little evidence of wear. It fractured in three places, at 1 ft. 10 in., 4 ft. 10 in. and 6 ft. 7 in. from the leaving end. Two fractures showed transverse fissures. Subsequent to the derailment an additional fracture was made in removing the rail and this disclosed a transverse fissure. Two more such fissures were disclosed in dropping the rail through some 6 ft. Parts of the rails were tested at the U. S. Bureau of Standards, in the Washington Navy Yard, at the laboratory of the railroad and at the works of the steel company. Metallographic examination was made by Wirt Tassin. Mr. Howard's conclusions were thus stated:

In conclusion it appears:

That the derailment of train No. 26 was due to a broken rail.

That the rail fractured under this train by reason of the presence of transverse fissures in its head, one of which was located 6 ft. 7 in. from the leaving end and is believed to have been the place of initial fracture.

That five transverse fissures were found in the rail ranging in diameter from ⅝ in. to 1¾ in.

That fissures of lesser extent were present in both this rail and a companion rail of the same heat, each of which had had the same term of service in the track.

That the metal in the heads of these rails was in a weakened state in certain affected zones, the affected zones being located near the center of the head and toward the gage side.

That the weakened and structurally impaired metal shown in the tensile tests was confirmed by the metallographic examination.

That the steel in other parts of the rail was structurally sound and possessed of normal strength.

That no slag inclusions were associated with the transverse fissures nor with the microfissures.

AMERICAN RAILWAY ACCIDENTS DUE TO BROKEN RAILS

| Year | Number of accidents | Killed | Injured | Damage including cost of clearing wreckage |
|---|---|---|---|---|
| 1902 | 78 | 5 | 207 | $128,769 |
| 1903 | 150 | 12 | 204 | 166,140 |
| 1904 | 176 | 9 | 139 | 157,682 |
| 1905 | 201 | 4 | 465 | 257 519 |
| 1906 | 220 | 7 | 635 | 254,862 |
| 1907 | 308 | 12 | 699 | 284,675 |
| 1908 | 238 | 16 | 433 | 296,327 |
| 1909 | 196 | 5 | 498 | 191,842 |
| 1910 | 243 | 24 | 369 | 293,899 |
| 1911 | 249 | 12 | 463 | 292,749 |
| 1912 | 363 | 52 | 1,065 | 511,778 |
| 1913 | 340 | 17 | 827 | 401,551 |
| Total | 2,762 | 175 | 6,004 | $3,237,793 |

Mr. Belnap appends the accompanying table of derailments caused by broken rails since July 1, 1901, to emphasize the importance which now attaches to safe rails.

**Drilling for Potash Deposits** will be continued by the U. S. Geological Survey during the summer of 1914. Previous similar explorations have been noted in "Engineering News," Jan. 25 and Apr. 25, 1912, pp. 140 and 806, Apr. 24, 1913, p. 829. Among other plans for the potash search for this year, the Survey expects to sink one or more deep wells in the Black Rock Desert, Nevada. Besides the deep well bored by the Geological Survey in the Carson Desert, several deep wells have been drilled by private interests during the last year, including some rather extensive work in Railroad Valley, Nevada, and several borings, some of which are a thousand feet deep, in Death Valley and Penamint Valley, California. Besides these a considerable amount of shallow drilling has also been done. Of all the localities explored the deposit at Searles Lake, California, seems to afford the most immediate promise of potash developments.

The site proposed for further work by the Geological Survey lies in the "sink" or low part of the Black Rock Desert, which was one of the principal arms of the prehistoric Lake Lahontan. The lakes that occupied these desert valleys were the recipients of all the natural salts contained in their tributary drainage waters. In certain of these basins, as Great Salt Lake, Owens Lake and Searles Lake, are known to have been concentrated immense bodies of saline and alkaline salts by this process of evaporation. In other basins, however, where the water bodies have since dried up, the salts have also disappeared and it is presumed that they must be buried under the surface of the desert deposits. The first test made in the Carson Desert was inconclusive so far as the discovery of any salt deposits is concerned. The site selected seems to have been situated too far from the center of the basin and only alluvial or river delta deposits were encountered in the drilling. As the central part of the Carson Desert, or so called sink, is a site difficult of access for drilling operations, being nearly always covered with water and a fill of soft deep mud, it seems best to select a site for a further test at some place where the central part of the main sink is more accessible. Such an area seems to be afforded in the Black Rock Desert. It is the center or low part of an immense arm or portion of the former Lake Lahontan. Its present surface is a bare, flat mud playa, occasionally submerged with water as a result of storms, but during the summer season generally dry and hard. It constitutes one of the largest of these concentration areas and in this respect is very fairly comparable with the Carson Sink.

# Steam Station for Long-Distance Power Transmission

By Frank G. Allen*

The Virginian Power Co. has built a 20,600-kw. steam-turbine generating station to serve the coal operations of the Kanawha and New River Districts within a radius of 50 miles of Charleston, W. Va. This plant has features which make it of unusual interest. These are briefly noted below.

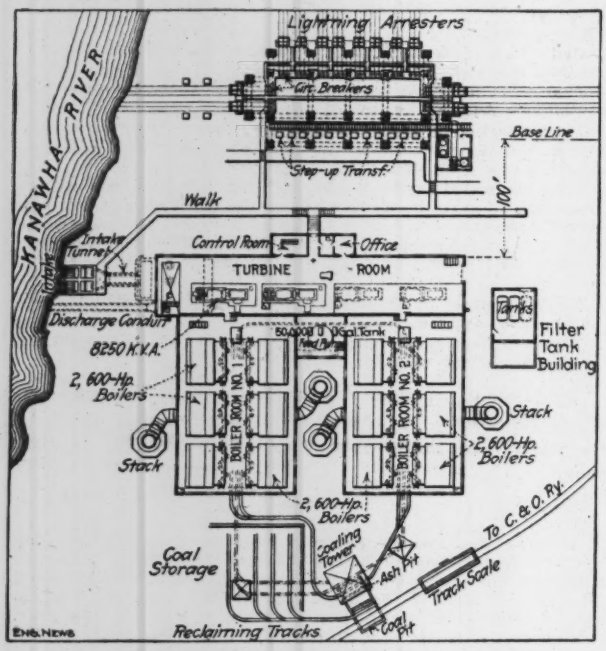



Fig. 1. General Layout of Cabin Creek Steam Station; Virginian Power Co.

Commercial Load—The market consists entirely in supplying power for coal-mining operations. These are in drift and shaft mines where electricity is or will be used for cutting, haulage, hoisting, ventilating, pumping, etc. Operations are on a 24-hr. basis and a station load factor of 35% is expected.

Property—The company owns eleven acres of land on the west bank of the Great Kanawha River at Cabin Creek Junction, W. Va., 15 miles from Charleston on the main line of the Chesapeake & Ohio Ry. This location affords abundant water of good quality for boilers and condensers, while being unusually accessible for the delivery of coal in carload lots from the Cabin Creek District by the payment of a switching charge. The coal used will be that of the region—run-of-mine slack as shipped.

Building—The two boiler houses and turbine house form a parallelogram with one side omitted, leaving an open court. The design called for two boiler houses in order (1) to permit of short pipe runs to the turbines; (2) to make the structure designs more symmetrical and to balance the boiler houses better with the room needed for turbines; (3) to give more light and air on all sides; (4) to make short and unitized boiler feed and blowoff lines and to facilitate central heating and pumping to all boiler units; (5) ability to make the second installation without any interference with operation.

The foundation and base courses are of concrete; the superstructure is a self-supporting steel skeleton inclosed with brick walls which are pilastered at the columns. Wall areas are broken by large windows. The frames and sash are of steel construction. Sills and trim are of white Georgia marble. Plainness of the walls is relieved by a deep brick cornice with parapet and concrete coping above.

The entire main and monitor roofs are concrete slabs reinforced with ribbed metal, covered with four-ply bituminous roofing felt laid in the usual way, flashed and counterflashed at the parapets. Bolted slag is spread on top to prevent flowing of the compound.

All the buildings have a ground floor at grade and a main operating floor at 14-ft. elevation above. This construction eliminates dark basements and affords natural light and air to all parts of the plant.

The floor systems are steel frames carrying reinforced-concrete slabs—all designed for a gross loading of 400 lb. per sq.ft. An "anti-dust" floor finish is used.

The present structures are ample in size to double the generating capacity of the first installation, including main generating units, boilers, stacks and auxiliaries.

A lean-to opens off from the machine room. This has a ground and a first floor. On the latter is the station control benchboard, a vestibule entrance for the power station, a chart room and a chief engineer's office. Below are the storage battery, power and lighting transformers and toilet rooms. Separate lavatories have been provided for the turbine-room and boiler-house forces. Both have porcelain plumbing and are finished with white Carrara glass (seconds, which can be purchased cheaply, prove to be excellent for such industrial services).

Boiler Plant—The boiler plant is laid out in two parts and each is separately housed. The first installation provides for the full equipment of one boiler house—six batteries of vertical water-tube high-pressure boilers with superheaters. Each battery consists of two 600-hp.

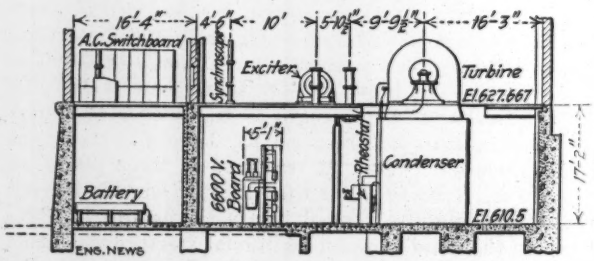



Fig. 2. Part Section through Turbine Building

boilers or 7200 hp. for the installation. Each boiler is equipped with automatic heavy-duty stokers in Dutch-oven setting.

The boiler house is divided into two units—each unit consisting of three batteries of boilers and stokers served by an independent stack of 11 ft. 4 in. inside diameter at the top by 262 ft. high; these are of steel plate, brick lined for the entire height. Natural draft alone is relied on. With the arrangement noted, the boilers and stokers can be forced to 200% rated capacity for peak

*Secretary to C. O. Lenz, Chief Engineer, Virginian Power Co., 71 Broadway, New York.

loads. Further limitation of the boiler installation is not warranted, as it may be in more congested centers and where more pronounced peaks have to be carried for short times.

Each boiler house is equipped with structural-steel, concrete-lined, elevated coal bunkers, occupying the middle bay of the boiler house. Their capacity is 12 tons per lineal foot.

The boiler-house ground floor is arranged with commodious ash bunkers under the boilers with tracks in front of the bunkers. Ashes can be raked out into one-ton cars and delivered into an ash bunker at an outside track hopper.

COAL-HANDLING PLANT—The fuel-storage plant consists (besides the boiler bunkers) of a structural-steel tower containing coal-receiving hoppers, crushers and machinery to work with double skip hoists. The same plant handles outgoing ashes from the plant, there being separate ash hoppers. All these bins are concrete lined. There is first a track hopper for incoming coal and this has a capacity for one full carload of 50 tons. The skips will be loaded by gravity from this. The tower will also have an operating platform at the proper elevation for the travel of the cable cars, which will deliver the crushed fuel from the coaling tower to the overhead boiler-room bunkers, as well as to the coal-storage pile.

The maximum capacity for hoisting, crushing and conveying lump coal will be 150 tons per hour. The ashes come from the boiler-room ground floor in one-ton cars and are dumped into a track bunker from which the coal skips are filled to lift the refuse to standard railway cars which are hauled over the same tracks on which coal is received.

This method of coal handling in connection with steam stations was adopted after an exhaustive study of such facilities made by the Engineer of the Virginian company some years ago in connection with another steam development at Youngstown, Ohio. The scheme is a modification of that perfected by the steel companies in handling materials for blast furnaces. The installation cost is greater but the operation cost is small, due to low maintenance.

GENERATOR UNITS, ETC.—The first installation consists of two 10,300-kv.-a. Parsons-type steam turbine units each equipped with a 90-kw. direct-connected exciter and an independent Le Blanc condenser. The latter are supported from the underside of the turbines, clear of the floor. The pumps of each are direct connected and driven by a 250-hp. re-entry steam turbine.

The plant is designed to operate at 180 lb. gage, 50° superheat, 28-in. vacuum. Intake and discharge of condensing water are through tunnels beneath the turbine-room floor.

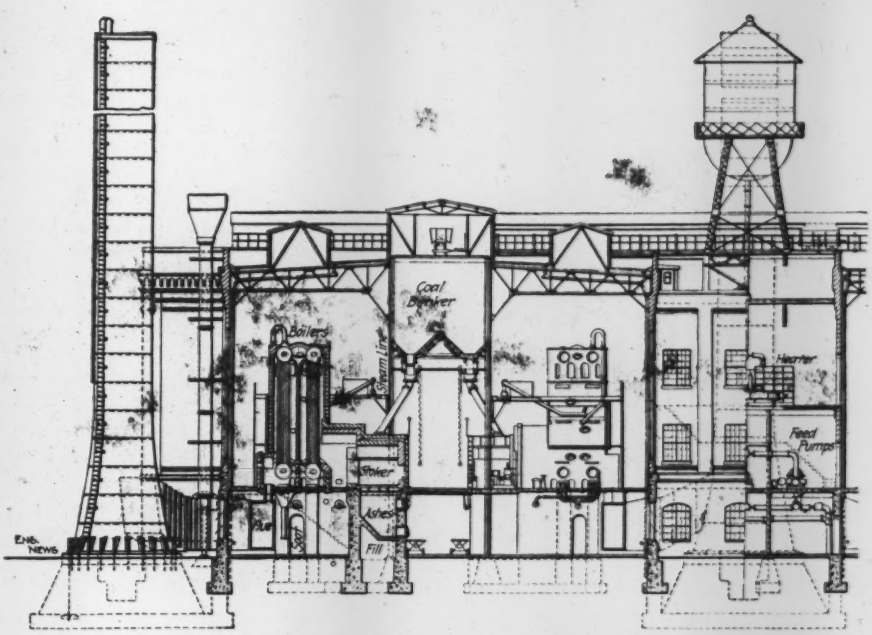



FIG. 3. SECTION THROUGH ONE BOILER HOUSE

This station can be operated on the unit plan—a unit consisting of one prime mover with its boilers, and a generator with its step-up transformers and feeders. Various interconnections are possible, however.

The main generators furnish three-phase current at 60 cycles 6600 volts and for a speed of 1800 r.p.m.

In addition to the exciters direct connected to the main units, a 100-kw. turbine-driven direct-connected exciter is provided for emergency. When the final two main units are put in they will not have the direct-connected exciters as there is sufficient direct-current capacity in the three present exciters.

To supply the condenser tunnel, there are two 24-in.

FIG. 4. COALING TOWER UNDER ERECTION

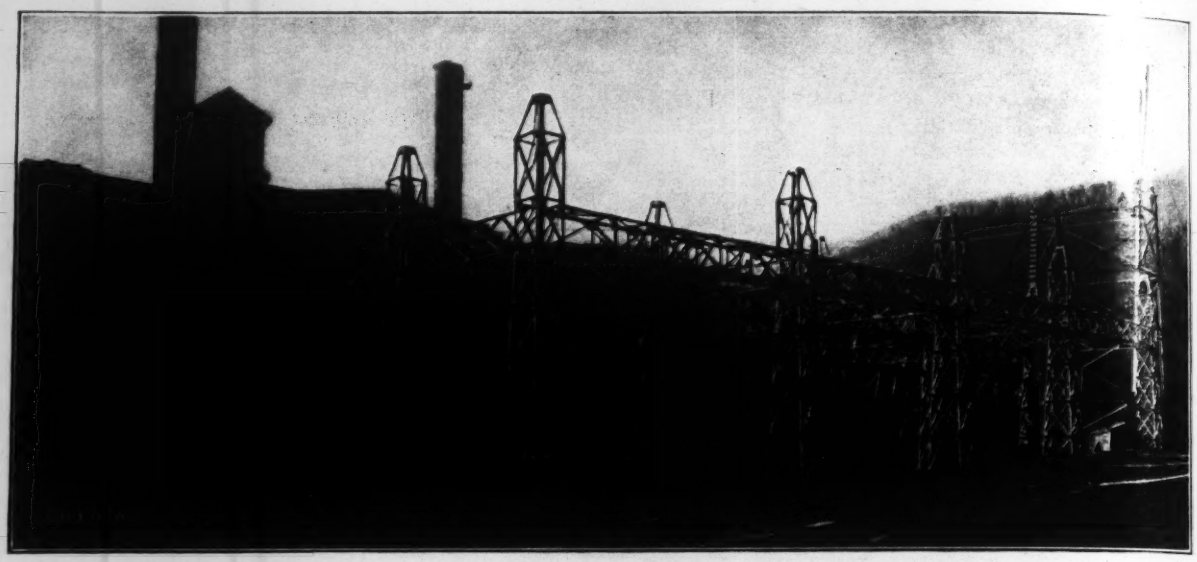


FIG. 5. STEELWORK FOR SWITCHING STATION

and one 18-in. turbine pumps; their capacities are for 17,000 and 8500 gal. per min.; the 24-in. turbine pumps are driven by 320-hp. induction motors and the smaller one by a 165-hp. steam turbine. Two 1000-gal. 6-in. centrifugals serve the house lines and elevate to a 50,000-gal. storage tank, directly or through pressure filters, for boiler feed, transformer cooling, general service. One of these is driven by a 75-hp. induction motor and the other by a 65-hp. reëntry steam turbine.

There are two open feed-water heaters and purifiers, each capable of supplying 10,000 hp. of boilers. As feed pumps, two 400-gal. 200-lb. centrifugals serve, each driven by a 96-hp. turbine.

SWITCHING—The control of the station and outgoing lines is centered in the switchboard room of the lean-to. The low-tension apparatus is on the ground floor but the high-tension equipment is all out of doors. Both low- and high-tension apparatus is remote controlled. All the usual switches, busses, etc., are seen for complete handling.

There are seven 2750-kv.-a. oil-insulated water-cooled single-phase transformers raising the generated voltage (6600) to 44,000 for transmission. All the now familiar high-tension apparatus, electrolytic lightning arresters, circuit-breakers, choke coils, disconnecting switches and bus lines, are installed on the ground, alongside or upon the steel framework. So far as known, this is the first use of outdoor switching for a steam plant.

TRANSMISSION LINE—The main line is 46 miles long—running to Beckley, W. Va. It is sectionalized at four division points, so that in case of trouble the whole length of a circuit need not be put out of service. There are two independent circuits carried entirely on steel structures, square anchor towers each half mile, with semiflexible

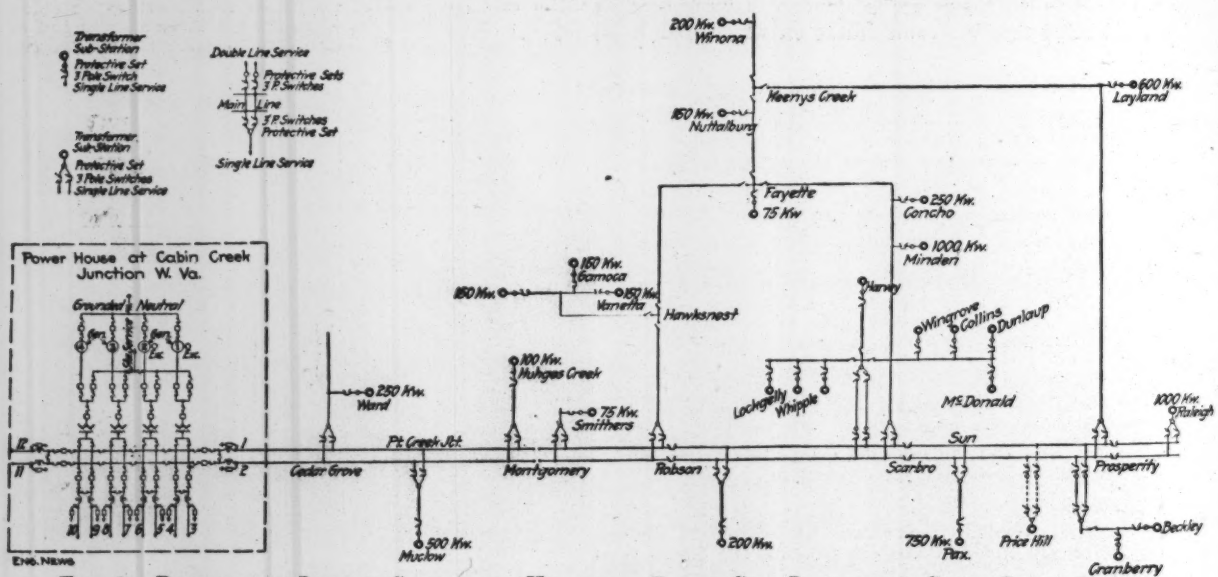



FIG. 6. DIAGRAM OF INITIAL SECTION OF VIRGINIAN POWER CO. LINES FROM CABIN CREEK JUNCTION

steel poles between. The three cables (No. 000 copper) of each circuit are vertically suspended; above each set is a galvanized-steel ground cable.

The distribution branches are led off from both the main circuit lines by take-off frames; the branch conductors are 40% copper-clad steel.

Great difficulty was encountered in the building of the various lines due to the extremely rough country through which they run. In many instances even mules could not be brought within a half mile of the tower site and the material has to be snaked up the mountain side by means of snatch blocks and pulleys.

The 44,000 volts is transmitted direct to the customers' transformers. Coal-mine operators are practically the only class of customer to be served and they call for transformer capacity of 100 to 2000 kw. The customers are thus all comparatively large users of energy and analysing their requirements is difficult.

It has been found advisable to use outdoor-type large-capacity transformer substations. These have rectangular frames of galvanized structural steel, the delta-connected transformers being carried beneath the switch-gear; in some cases the metering with its attendent current and potential transformers is housed in the frame. The low-voltage side of the transformers is carried directly to the individual substations owned by the customers themselves. Here the current is converted into direct or retained alternating—according to the work required.

Employees' Houses—Houses will be built by the company to house its employees. These will consist of a two-story brick cottage for the chief operating engineer and six separate brick houses (four rooms and bath) of the bungalow type for the operators with families. A brick bunk house will take care of the remainder of the employees. All these houses will have electric lights; heat will be supplied by exhaust steam and a septic sewage-disposal system will be provided.

General—The boilers were made by the Babcock & Wilcox Co.; steam turbines and practically all the electrical apparatus by the Westinghouse companies, the many hydraulic service pumps by the I. P. Morris and R. D. Wood companies.

C. O. Lenz, 71 Broadway, New York City, is Chief Engineer responsible for design and construction; he has been represented in the field by H. G. Scott, General Manager of the Virginian Power Co., and J. P. Harrington, Resident Engineer for Construction.

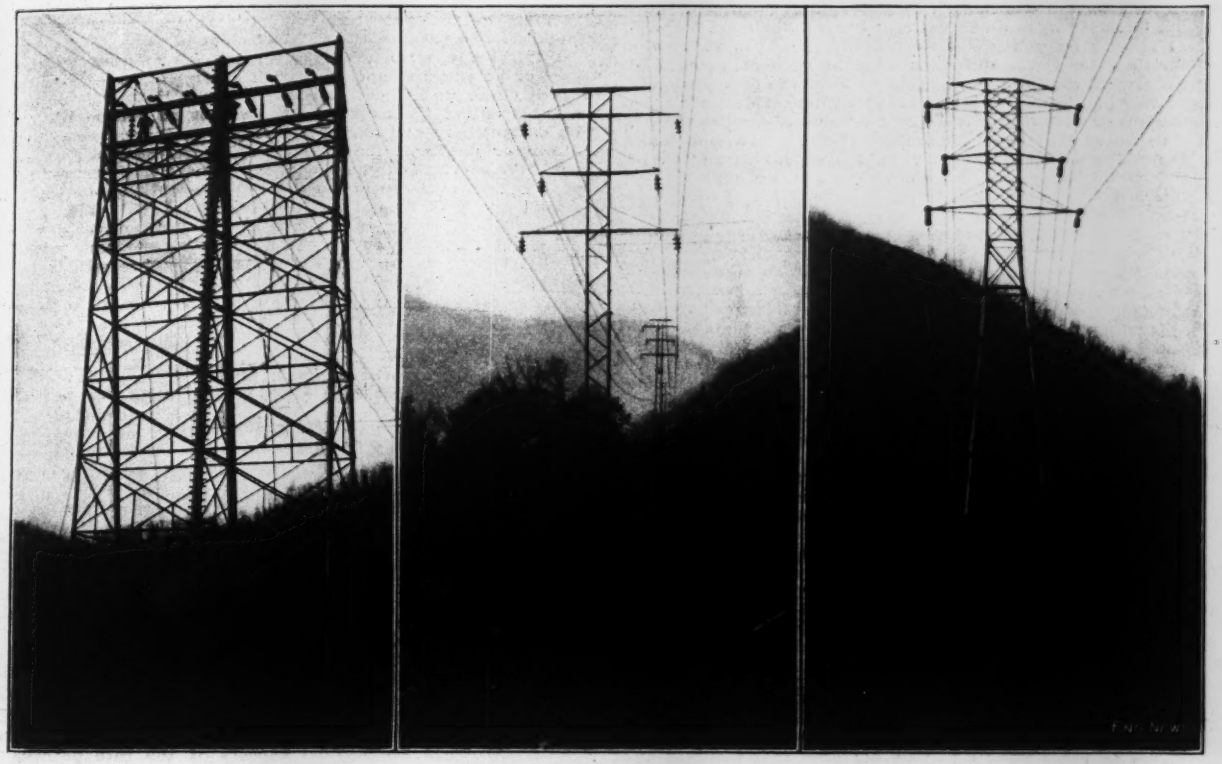


Fig. 7. River Tower, Steel Pole and Anchor Tower; Showing Difficulties of Location

**Sand-Lime Brick Industry Growing**—The output last year reported to the United States Geological Survey was valued at $1,238,325, or $12,556 more than in 1907, the year of maximum value prior to 1913, and $38,102 more than in 1912. The average price per thousand for common sand-lime brick was $6.27 in 1913, compared with $6.46 in 1912 and $6.09 in 1911; for front brick it was $10.61 in 1913, against $10.41 in 1912 and $9.53 in 1911. The sand-lime brick industry has been the victim of "boomers." Early in its history it suffered severely by reason of glittering promises to make for a few dollars a thousand brick that would sell in competition with high-grade clay face brick. Plants were established for the manufacture of sand-lime brick without regard to market, transportation facilities, or even a supply of suitable materials. Later came the natural reaction, with a decrease in the number of operating plants. Within the last few years the industry seems to have become firmly established and is showing a reasonable growth.

# Value of Public-Utility Service as a Basis of Rates*

The Committee has considered that facts dealing with investment and rate of return are beyond the scope of its work, and has therefore devoted the time at its disposal to the consideration of the theory of rates, and differentials between the various classes of service, and the proper rates applicable to each.

We believe the importance of this work is also recognized by the commissions. Even the commissions that base their rate determinations upon valuations are forced, when they come to the actual determination of the individual rate, to depart from the mathematical exactness that a detailed valuation implies; and the great amount of labor and expense in determining the valuation and fair rate of return can only be used in determining the amount of net revenue which the company is entitled to receive for its corporate purposes.

In fixing the individual rates for each class of service they are forced, on the one hand, to consider that maximum rates cannot be based upon an actual cost theory, but must be governed largely by policy and by precedent; and in fixing the wholesale rates, the commissions have in general recognized that a central station must be free to meet the competition of the private plant. In the latter case they depart entirely from the cost-of-service theory and adopt a value-of-service theory, but in general they have not recognized the great importance of the value of service theory in the actual formation of electric-lighting rates. A special report upon value of service has been added, and is recommended for careful consideration.

The Committee believes that there are two fundamental principles:

(1) That the rates of a company should, as a whole, produce an income sufficient to give a fair return on the investment and attract capital freely to the enterprise. The gross earnings from the sale of the product must, therefore, be sufficient to cover all the necessary expenses of operation, including taxes, bad debts, etc., a reserve for renewals and contingencies, interest at current rates, and a reasonable profit in addition.

(2)—The Committee believes that when the rates as a whole are giving a fair return on the investment as above provided for, then the rates to separate individuals and classes which go to make up the rates as a whole, should be so adjusted as to make the total cost as low as possible, and the service rendered as great as possible, by means of the most effective utilization of the plant.

The Committee has further come to the conclusion that these results can best be obtained by adjusting the various rates to the value of the service rendered, giving proper consideration also to the relative costs of service, and defining value of the service rendered as the amount which the user would have to pay for the same or equivalent service under absolutely fair but not destructive competition; in other words, the amount at which the user could serve himself or provide an equivalent or substitute means of service under free but not destructive competition.

PROFITABLE AND UNPROFITABLE REDUCTION—If a reduction in rates results in new business that involves additional expense greater than the additional income, thereby reducing the net income, such a rate is less than the cost or value to the seller, is unprofitable, and does not satisfy the requirements of the cost-of-service tests. Such rates would not be made under free competition, except when reasons of company policy are the determining factor rather than the value to the seller.

If, however, the reduction of the rate to the prospective buyer is (1) down just to the value to him, so that business results, is (2) not below the cost or value to the seller, so that it brings in more added income than the added expense, and (3) does not involve any reduction of income from other buyers, then the result is profitable to the seller.

Such reductions are always possible until finally all classes that can be supplied are supplied, and this means a balance between the amounts of business done in the different classes so as to use the investment most efficiently.

THE PROFIT TO THE SELLER—The result of these reductions is at first an increase of profit to the seller. When the profits to the seller are increased so as to be excessive and to exceed a fair return, whether by such a reduction as described or by any reduction in the seller's total costs, then the original seller should reduce the rates or a new seller is likely to come in and do business at lower rates.

However, unless some of the profits are given to the seller, there will be no incentive to him to plan for a reduction of any sort, and this profit for the seller above an ordinary return is only his fair return for the extra skill in management, initiative, risk or energy that makes the reduction possible.

COMPETITION—Competition of other methods with certain classes only would naturally affect only those classes and those rates. Competition (actual or potential) of the same methods by a similar seller affects all classes momentarily, but later affects only some. Free competition of another seller doing all the work in exactly the same way may momentarily affect all classes and all rates, but a reduction would not affect equally the business in the different classes. In some cases, a reduction might increase business not at all; in others, greatly.

In all the cases, the new rates would, under free competition, gradually adjust themselves just as before, so as to produce amounts of business in the various classes that together would utilize the investment most efficiently. The rates, therefore, would in each class finally adjust the aselves according to the potential competition; i.e., according to value, so as to produce the most efficient balance.

It follows, therefore, that all rates are affected by the actual or potential competition from other methods met with in each class, and if competition is free all along the line, the rates adjust themselves to the values as determined by such competition; and any set of rates, whether at the start uniform or not, will finally adjust themselves along these lines if the service is to be used most efficiently. It cannot be too often repeated, however, that the competition herewith referred to is the kind of competition that is fair and permanent, and not merely temporary or destructive.

It should be noted that when a supplying company withholds service from any potential buyer who is willing to pay more than the added expense of supplying him, then this refusal of service hurts all the other buyers, since, if he were supplied at a rate that showed any profit at all, the additional business obtained would, in the long run, help the other buyers.

However, the rate asked from him, if it is going to be lower than that charged the other buyers, should be just as high as he can afford to pay, but when it is just as high as he can afford to pay, then the fact that it is lower than to the other buyers is of no disadvantage to them, while the profit that he brings in is ultimately for their advantage. It is assumed, of course, that the rates are the same to all buyers supplied under the same or substantially the same conditions.

The problem, therefore, is to determine the value in each case; i.e., what each class can afford to pay, rather than get along without the service. It is not so much a question of what one individual can pay, but of what the class as a whole will pay so as to preserve the balance between the business of that class and the whole, or to readjust the balance so as to use the investment more efficiently.

EXCEPTIONS—We may note some exceptions to the general rule that rates depend only on values: (1) When monopoly profits are allowed; (2) when monopoly profits are taken by government authority for itself or for certain classes; (3) when sociological aspects of the rate problem control as in taxing the users of electric light for certain municipal purposes or for the benefit of a certain class of the community, or when the controlling authority forbids any difference in rates to individuals because of skill in trading for a lower price, or when a city wants to develop its vacant land, and hence requires uniform utility rates in all its territory, and when the controlling authority requires that rates should be fairly uniform in respect to time.

QUESTION IS TO DETERMINE VALUES—The simplest method is, of course, for the seller to use his judgment as to the value of the service rendered in any particular case. This is the method used by the lawyers, doctors, ministers, artists and also in many commercial businesses; but whenever there are numerous values to be determined, especially if they are to be determined beforehand, this method becomes impracticable, and some test or method of differentiation must be adopted.

When a test is used it can never be perfect, but the loss and disadvantage of the cases when the test does not perfectly discriminate according to value, is less than the trouble of deciding each case separately.

In discussing various tests of value, we shall attempt to confine ourselves to general principles.

PHYSICAL TEST—Things that are physically different, as oats and straw, have different values, even if the product of the same operation. Sometimes one of these is known as the principal product, and the others as byproducts, but the byproduct may often become the principal product, and when

*From a report of the Rate Research Committee of the National Electric Light Association, Philadelphia Convention, June 3, 1914. See also editorial discussion in this issue.—Ed.

there are numerous products of a single operation, it is impossible to say which are the byproducts. Kilowatt hours, ampere hours, kilowatts of demand and the connected load are all physical tests when applied to the consumer of electricity.

TIME TEST—Things that are physically the same may have different values at different seasons, as ice and fruit. The supply of electricity in summer, as compared with winter, is of this class, and so is the business supplied on any so called "off peak" rate.

PLACE TEST—Things that are physically the same have different values at different places. Coal is of different value at the mine than it is at the pit, and electricity is of more value in the city than at the waterfall.

LIMITATIONS—All of these differences in values are limited by the possibility of substitution; i.e., aluminum can be substituted for copper for most uses, and for these uses its price cannot get away from a certain ratio to the copper price. Copper price may affect iron price, iron price may affect wood, wood may affect coal, coal may affect food, food may affect oats, etc. In the same way, difference in value according to time is limited by cost of storage, and difference in value according to place by cost of transportation.

USE TEST—There are variations in value according to use; i.e., aluminum is worth some definite proportion of the price of copper whenever it is to be used for overhead lines, but if it is to be used for underground lines requiring insulation, then it is not worth as much. This variation in value according to use is, as before, limited by the possibility of substitution. These tests of value by use are very prominent in the government postal service. The rates for postcards, circulars, sealed letters, etc., are all tests of value, according to use. In electricity the power rate, as distinguished from the lighting rate, is a test of value according to use.

USER TEST—There are variations in value according to the user. For instance, furs are of more value to an eskimo than to an inhabitant of the tropics. As before, this variation is limited by the possibility of substitution, since if the purchaser at the low rate can resell, there will be no business done at the higher rate, and the actual values, as determined by the business done, will all be the same.

When a rate is made to members of certain societies, then the test of value is according to the user, and a rate made to churches or charitable societies is a test of value according to user.

It may be noted that a variation in value according to user is in many cases really a variation according to use; as for instance, a telephone rate of one amount to residences and another amount to business places is, on its face, a difference in rate or test of value according to user. Yet it may just as well be said that this is a test according to use.

OUTPUT TEST—There are further variations in the value that arise when a total output varies; as for instance, an article may be produced by hand at one cost or value, irrespective of output, but if made by a machine, the cost or value for making a single article will be much greater, and for a very large number of articles, very much less than hand-made prices.

It may be noted that the cost does not always go down as the output increases. When only a few machines are being used, the cost may go up temporarily when the capacity of the first machine is reached, and a second is necessary for a small increase in output. Further, there are at least two businesses where the cost per unit increases with the output. One is the telephone business. Where the service covers a large city it cannot be operated at as low a cost per customer as a station located in a small town. The second is the hotel business.

While other tests of value may be used, it is thought that in general all the tests can be classified among one of these six classes—physical, time, place, use, user and output. It is important to note, however, that when a difference in rate is made, there must be a difference in value both to the seller and the buyer, so as to make the rate effective.

Now, of these several tests of value, the physical test and also time and place can be used to test values to either the seller or the buyer, while the tests of use and user apply only to the buyer and the test of output only to the seller. Hence, in making a rate, physical conditions or time or place can be used alone, since such differences in value apply both to the buyer and the seller, but if use is to be made a test of value, this can be done only when some other tests apply also to the seller; as for instance, the output or time; and vice versa, if output affects value to seller, it can be applied only when one of the other tests also applies to the buyer.

# A Grand Jury Rebuked

The Board of Direction of the American Society of Civil Engineers has adopted the following resolution in regard to the Grand Jury presentment on the Consulting Engineers of the Board of Water-Supply of New York City, reported in ENGINEERING NEWS, Apr. 30, 1914, p. 970.

Whereas, the Special Grand Jury of the County of New York, as reported and widely circulated in the daily press, has recently made a presentment impugning the professional standing and honor of the three Consulting Engineers of the Board of Water Supply of New York, one of whom has since that time died honored and revered by the entire engineering profession and by all who knew him; and

Whereas, the presentment in question sets forth the opinion of the Grand Jury in this matter substantially as follows:

That the employment by the said Board of Water Supply of a staff of salaried consulting engineers can only be justified upon the theory that these consulting engineers are such in fact and that when called upon for the expression of an opinion in connection with any contemplated work that such opinion, when expressed, is their own independent opinion, reached by them without fore-knowledge of the opinion already formed and expressed by the regular engineering staff of the said Board of Water Supply.

The evidence presented to us shows that in certain instances the opinion of two of the three consulting engineers at present employed by the said Board of Water Supply was a mere reiteration of that already expressed by the chief engineer of the said Board of Water Supply, with a copy of which the consulting engineers had been provided before their own opinion was expressed. The third consulting engineer in one case, the only one who appears to have acted at all independently of the chief engineer of the said Board of Water Supply in his final report disagreed with the other two, and his opinion was not acted upon, and it is our belief that the work involved cost the city of New York approximately two hundred and fifty thousand dollars more than would have been the case had this last opinion been adopted.

During this investigation the three consulting engineers now employed by the said Board of Water Supply suggested to the said Board that their salaries be reduced from six thousand dollars to three thousand dollars a year each and this reduction was made on Jan. 1, 1914. If the opinions of these consulting engineers are to be, in the future, a mere reiteration of the opinions expressed by the regular engineering staff of the said Board it would be for the best interests of the city that they resign, and those positions be abolished.

and

Whereas, the standing and attainments of all three of the said Consulting Engineers is well known to be such that any professional opinion emanating from them or from any one of them could not be other than independent and reliable: and

Whereas, the mode of professional procedure advocated by said Grand Jury is not consistent with good business, and, if carried out, would result in practice which would be neither ethical, nor professional, and would be contrary to that established by experience the world over in the Engineering, Architectural, Medical and Legal Professions, in that it would deprive consultants of information regarding the course previously pursued by the engineer in charge, and would require each one of them to duplicate much of the work already performed by the regular engineering organization in preliminary investigations, studies, estimates and analyses, and thereby greatly increase the engineering expense without attendant advantage or benefit., be it

Resolved, that the Board of Direction of the American Society of Civil Engineers wishes to place on record its condemnation of a procedure which permits a public criticism of sound and proper professional practice, and, based upon such erroneous criticism, a reflection on the honor, integrity and professional standing of reputable engineers; and be it further

Resolved, that the secretary of the Society be instructed to forward a copy of these resolutions to the presiding judge of the court to which this Special Grand Jury reported, to the District Attorney of the County of New York, to the Mayor of the City of New York, and to the technical and secular press.

**A Diesel Electric Railway Motor Car** has been tested on the railways of Sweden. The car is driven by electric motors which are furnished with current by a generator mounted on the car driven by a Diesel oil engine. The whole equipment was built in Sweden. The motor car accommodates 50 passengers and weighs about 70,000 lb. The car has run over 2000 miles on the Swedish railways since the beginning of the year, usually at speeds of 20 to 35 mi. per hour. The engine burns crude oil distilled from Swedish shale and the fuel consumption is about 9 lb. per mile.

## Proposed Memorial to Alfred Noble: Tributes from Brother Engineers and Co-Workers

A committee appointed at a recent meeting of the Board of Direction of the American Society of Civil Engineers, consisting of Messrs. T. Kennard Thomson, chairman; Charles Warren Hunt and J. H. Edwards has reported as follows:

That, in the opinion of the Committee, a memorial to Alfred Noble is desirable, and should be undertaken by this Society, and should be on no small scale. The Committee suggests that the Civil Engineers of the world be asked to subscribe to the funds for this purpose, and that the memorial take the form of an appropriate bronze statue to be erected in some suitable place.

In view of the fact that much of Alfred Noble's professional practice was national in character; that he was an adviser of Presidents, and consulted in some of the most important engineering work of the country, the Committee believes that such a recognition of him personally, and of the profession of engineering, would meet with universal approval.

It is, therefore, the opinion of the Committee that the capitol of the nation is the proper location for such a statue, and that the Congress or other body in authority, be requested to provide a suitable site. The Committee, therefore, makes the following recommendations:

(1) That this Society undertake the erection, in a suitable location, of a statue to the memory of Alfred Noble—the engineer and the man.

(2) That the Board of Direction immediately set aside the sum of $1000 as the first subscription toward the necessary funds.

(3) That the funds for this purpose be secured by subscription from the engineers of the world.

(4) That a committee of five be appointed by the Board, in whose hands the carrying out of the project be placed.

The report was received and its recommendations adopted by the Board of Direction at the meeting of June 2. A permanent committee was appointed to carry the resolutions into execution, consisting of Messrs. Onward Bates, of Chicago, Ill.; Robert Moore, of St. Louis, Mo.; Samuel Rea, of New York City; Samuel H. Hedges, of Seattle, Wash.; F. H. Newell, of Washington, D. C., and Charles Warren Hunt, Secretary of the Society.

The Board of Direction adopted the following resolutions on the death of Alfred Noble, Past-President:

Whereas, by the death of Alfred Noble the engineering profession in America has lost its most prominent member, and

Whereas, Mr. Noble has been connected with this Society for forty years, and has served upon its Board of Direction for nine years, as Director, Vice-President, President, and finally as a Past-President, be it

Resolved, that the Board of Direction of the American Society of Civil Engineers acknowledges the indebtedness of the profession to this wise counselor, active and tireless worker, who, during his connection with this Board and subsequently gave ungrudgingly and unselfishly so much of his valuable time for the general good, and be it further

Resolved, that this Board desires to spread upon its records its sense of profound sorrow in the great loss, not only to the profession of engineering, but to the world, of one who by his strong and intellectual personality, earnestness of purpose, sterling honesty, and great heart, has set an example for Engineers of the future, and in so doing endeared himself to all with whom he came in contact.

The Joint Conference on Uniform Methods of Tests and Standard Specifications for Cement, consisting of Arthur P. Davis, Olaff Hoff, Richard L. Humphrey, Asa E. Phillips, Clifford Richardson, George F. Swain, George S. Webster and Rudolph J. Wig, has adopted the following resolution:

The Joint Conference on Uniform Methods of Tests and Standard Specifications for Cement hereby records with profound sorrow the irreparable loss sustained in the death of its Chairman, Alfred Noble, and its deep gratitude for the privilege of having known and been associated with one who was the exponent of the highest ideals as a man, as a citizen and as an engineer.

Mr. Noble has given much to the engineering profession and his unselfish work in the development of the methods of testing cement has been of incalculable value. Many of his contributions to the engineering profession to be found in the "Transactions" of the American Society of Civil Engineers relate to this branch of engineering. He was a member of the Special Committees of this Society which presented reports on Uniform Methods of Tests of Cement in 1885 and 1912.

The members of this Conference find themselves unable to adequately express their loss. This intimate association with Mr. Noble has left in the memory of each member an indelible impression of his patient, sweet, endearing nature, of his simple, forceful, dignified personality and of the grandeur of his character.

## Greater Power Development at Sault Ste. Marie

On May 28, the Secretary of War executed a lease to the Michigan Northern Power Co., for the use of 25,000 cu.ft. per sec. of water, with provisions for additional water during high-water periods, at the option of the Secretary.

The compensating works required on the two sides of the river will consist of 16 Stoney sluice gates, of about 52-ft. span each, and a dike to obstruct the entire flow of the river when necessary. Eight of the gates are to be built by the United States and eight by Canadian interests. The twelve new gates proposed are similar to the four already in place (described in *Transactions*, American Society of Civil Engineers, Vol. LIV, p. 346).

When the gates and both canals are completed, it is expected the monthly mean level of Lake Superior may be controlled within a maximum range of 2.5 ft. (former range, natural, about 4.5 ft.), and that usually the range will be but 1.5 ft. There is sufficient excess capacity provided so that one canal may be entirely closed without resulting in unduly high stages of the Lake.

When completed, the power canals, as well as the compensating works, will be under the direct control of a Board, consisting of one officer from the United States and one from Canada, so far as such control may be necessary to the maintenance of lake levels and the needs of navigation.

The U. S. River and Harbor Act, approved Mar. 3, 1909, provided for (1) the taking of all lands and property north of St. Mary's Falls Ship Canal to the international boundary; (2) perpetual reserve of water-rights primarily for navigation and incidentally for power development directly by the government or by 30-year lease.

The Michigan Lake Superior Power Co., which constructed the water-power plant described in ENGINEERING NEWS of Sept. 25, 1902, applied to the Secretary of War for the lease of the water required to operate its plant. The rights of this company were purchased a little later by the Michigan Northern Power Co., and the latter company completed the steps necessary to obtain water for its use.

The power house of the Edison Sault Electric Co. (acquired by the government), together with water for its operation, was leased to the company by the Secretary of War on June 25, 1912. It is expected that about 5000 sec.ft. will be used by this company, although only a part of the development has been completed as yet.

At the War Department required provision for controlling the level of Lake Superior, the company submitted a general plan for compensating works, prepared by Messrs. Noble and Woodard, and this was approved. The company then applied to the International Joint Commission for approval of the plans of compensating works, and permission to construct them and to divert into its power canal in accordance with a lease to be executed by the Secretary of War.

At about the same time the Algoma Steel Co., on the Canadian side, took similar steps to obtain permission to use water on that side of the river, assuming its share of the burden of constructing and maintaining the necessary compensating works in the Rapids. In this way the plans of the two companies could be treated as a unit so far as they controlled the water level of Lake Superior. Four new gates are to be built by the Canadian interests and twelve by the Americans. While it is understood that the Algoma application has been approved, it is not known whether its development will be completed at once. However, the Michigan company is expected to proceed at once with its work.

Some 105,000 hp. will be produced by the completed developments on both sides of the River (American and Canadian).

## Breaks in Two Water-Supply Mains at Denver

Breaks in two of six water-supply mains of the Denver Union Water Co., Denver, Colo., due to high water in the South Platte River, led to exaggerated press reports on June 15 regarding flood damage and water shortage in Denver. The facts in the case, as obtained by wire from M. C. Hinderlider, of Denver, are as follows:

Owing to the heavy snowfall of last winter and the unusual rains since then the South Platte River has had a greater spring flow than ever before in the history of Denver. At no time have the floods been considered generally dangerous to life or property, although a number of bridges have been washed out, some valley lands flooded and about 400 ft. of 30-in. and 50 ft. of 48-in. wood-stave conduits of the Denver Union Water Co. destroyed. These conduits lead into the city across land that was submerged to a depth of 1 to 3 ft. The exact cause of the conduit breaks is not yet apparent.

As to water shortage, this began before the floods which broke two of the six supply conduits, but at no time has it been as serious as the press dispatches indicated. On hot days the demand for water is about 72,000,000 gal. a day. For several days the supply was reduced to about 60,000,000 gal., as water in the distributing reservoirs was reduced. On Saturday evening, June 13, the city council ordered that lawn irrigation and other uses of water not absolutely necessary be discontinued for a few days. Heavy rains on June 14 and 15 made this discontinuance unnecessary and when Mr. Hinderlider wired late on June 15 it was reported that the reservoirs were filling and that repairs to the broken conduits would be completed within two days.

On no day was less than 60,000,000 gal. furnished, *or 250 gal. per capita.* It is true, Mr. Hinderlider adds, that there has been light pressure and inadequate supply in parts of the city and that water wagons have been sent out to meet domestic requirements.

## NEWS NOTES

**A Runaway Barge Damaged a Steel Drawbridge** of the Wheeling & Lake Erie R.R. across the Maumee River at Cleveland, Ohio, on June 14. The "G. E. Hartnell," owned by the Northwestern Navigation Co., snapped her 125-ft. towline and crashed into the bridge, carrying away a 150-ft. span adjoining the draw span, loosened a pier, and damaged part of another span. The channel was not closed.

**A Gas-Main Explosion in Columbus, Ohio,** on June 14, due to a lighted match, killed five workmen and injured 15 others. The accident occurred in a trench of the Ohio Fuel Supply Co.; a 12-in. natural-gas main had been tapped for a connection, and 50 men were at work in the trench. The foreman believes that a blind flange or "dead cap" was blown off and the escaping gas then ignited by the match struck by one of the workmen.

**Streets Cave-In in Paris Storm**—A 3-hr. thunderstorm in Paris on June 15, caused the death of about 14 persons and much damage to property. About 500 sq.ft. of pavement at Place St. Philippe du Roule and Rue du Faubourg St. Honoré, sank due to bursted sewers. Gas and water mains, telephone and electric-lighting circuits, were broken. Later, a second collapse occurred on the Place St. Philippe du Roule, leaving a hole in the pavement 130 ft. long.

**A Chloride of Lime Explosion** occurred on the second floor of the wholesale oil and chemical plant of the Fred G. Clark Co., Cleveland, Ohio, at about 3 p.m., on June 10. Two barrels of the lime were involved in the explosion. Employees of the company, thinking the building was on fire, threw water by means of the company's fire hose into the bursted barrels, generating gas in large quantities. Twenty-three members of the Cleveland fire department, responding to the alarm, were more or less poisoned by the liberated gas. The serious effects of the gas were not immediately noticed by the men all of whom had returned to the engine houses before being overcome. The manager of the chemical company stated that the explosion was caused by the barrels absorbing water used to scrub the floors.

**Six Gates Torn Away at the Welland Canal**—Traffic on the Welland Canal was stopped when the steamer "Pueblo" of the Canadian Cement Co., Montreal, Que., laden with coal caused six gates to be carried away at Lock 9. She had just entered the lock and the locktenders were about to close the headgates when Capt. McMann observed that his ship had too much headway to avoid touching the foot gates. Upon signaling, the engineer, instead of reversing the engine, sent the ship full speed ahead, pushing out the gates. The rush of water to the lower level tore the head gates from their fastenings, and in addition put the two headgates of Lock 8, below, out of commission. The latter gates were being opened to receive the "Pueblo" when the flood occurred. The overflow tore large holes in the outside of the clay embankment of the canal.

**A Collision at Sea** occurred between the Hamburg-American Liner "Pretoria" eastbound, and the westbound "New York," of the American Line, at about 1 a.m., on June 13, in a dense fog, 400 mi. east of Ambrose Channel. A hole 12 ft. high and 32 ft. long was torn in the port bow of the "New York," 15 ft. above the water line. The port anchor of the "Pretoria" was embedded in the breach. The port bow of the "Pretoria" was slightly damaged, about 20 ft. above the water line. Upon determining that the damage was not serious, the ships proceeded on their respective voyages.

An inquiry was begun on June 17, by the Board of Inspectors of Steam Vessels to ascertain the facts of the collision.

Repair work began on the "New York' on June 15. The damaged steel plates were removed by the oxyacetylene flame; this work was carried on from the deck of a lighter. The "Pretoria's" port anchor, weighing about three tons, was hoisted out of the stoker's washroom on the "New York," by means of a wrecking derrick. The port anchor of the "New York" was lifted to the pier also, for repairs.

**General Plans for the Hetch Hetchy Water-Supply** for San Francisco were approved by Secretary of the Interior Lane on June 11. The plans cover the Hetch Hetchy and the Cherry Valley reservoir sites, and also the aqueduct line over public lands.

**Bids for Asphalt Pavements in Salt Lake City, Utah,** have jumped from $1.98 to $2.35 per sq.yd. in the past year, according to a recent newspaper dispatch. Last year there was

sharp competition between the contractors using rock asphalt and those using the refined California asphalts, but this year there appears to be more harmony between the two groups and all bids were found to range from $2.25 to $2.39 per sq.yd., chiefly about $2.35.

**Philadelphia Highway Work in 1913**—A comparison of the amount of work performed by the Bureau of Highways during 1913 with former years shows that the work done exceeds the average amount per year in the eight preceding years by 48%, and is 3% more than the largest amount, and 103% more than the smallest amount done in any one year in the same period.—From recent Report of Wm. H. Connell, Chief of Philadelphia Bureau of Highways.

**Lighting a Railway Freight Yard** by means of electric lamps at a height of 100 ft. is being tried in the classification yard of the Pittsburgh & Lake Erie R.R. at McKees Rocks, near Pittsburgh, Penn. Instead of lamps on tall poles between the tracks, there are eight steel towers 100 ft. high placed along the sides of the yard, and each carrying powerful mercury arc lamps. This system of lighting has been worked out by D. P. Morrison, Electrical Engineer of the P. & L. E. R.R.

**Vacation Without Pay**—With the exception of the employees of the transportation and mechanical departments, all employees and officers, from office boy to president, of the St. Louis Southwestern Ry., will be forced to take a three days' vacation without pay during the month of June, according to press despatches. The reason is poor business. It is estimated that the saving effected by this means will amount to $12,000. The three-day furlough takes the place of cutting down the force.

**A Study of Needed Additions to the Water Supply of Philadelphia,** to be made by one or more engineers at a probable expense of $15,000, has been recommended to the Finance Committee of the Philadelphia Councils by Morris L. Cooke, Director of Public Works. Mr. Cooke points out that notwithstanding what has been done in "reducing the losses through the distribution system, and in gaining the coöperation of the public in eliminating the waste of water" the present supply will not be adequate for "more than five to ten years under the most favorable circumstances which we are likely to encounter."

**The Hudson River Region Produced 1,025,308,000 Bricks in 1913,** valued at $5,636,061, according to Jefferson Middleton, of the United States Geological Survey, Washington, D. C. This is less than the 1912 figures by 207,879,000 bricks. New York is the leading market for common brick in the United States, and is supplied principally from the Hudson River region extending from New York to Cohoes on both sides of the river, from Bergen County and the Raritan River region in New Jersey. When prices are high—say $7 per M.—Connecticut ships brick to New York. The average price in 1913 was $5.50 per M.

**A Sewage-Sedimentation Plant** at Morton Grove, Ill., to be built by the Sanitary District of Chicago, has been authorized by an ordinance passed by the village authorities and accepted by the Sanitary District. This work is in connection with the system of intercepting sewers proposed to take the sewage now discharged into Lake Michigan by several residence towns north of Chicago, and deliver it to the north branch of the Chicago River. The purpose of the plant is to remove organic matter and other material which would otherwise be deposited in the river and cause pollution. The main intercepting sewer will connect with the 32x48-in. concrete outfall sewer at Dempster St., Morton Grove, and divert its flow to the sedimentation plant, from which an effluent pipe will lead to the north branch of the Chicago River. As the sedimentation treatment is of an experimental nature, the ordinance provides that the use of the plant may be discontinued whenever the chief engineer of the Sanitary District considers that this method of treatment should be abandoned.

**Increasing the Efficiency of Street-Cleaning Contractors**—Philadelphia, Penn., is the only large city which does its street-cleaning work by contract. The uniforming of the men employed under these contracts has marked a new era in street-cleaning work in Philadelphia, and has met with universal approval. Aside from the generally pleasing appearance of the "white wings," there has been a marked advance in the esprit de corps among the men, which has raised the standard of the work performed; and last, but not least, the innovations inaugurated in conducting this important branch of the municipal service has placed the contractors on their mettle and has tended to arouse their pride in the work in their respective districts. Through promoting friendly rivalry among the contractors, it is hoped that the standard of their respective organizations will be improved, which will not only give them a more complete control over their work, resulting in a direct economy to them, but will generally improve the service rendered to the city.—From recent Report of the Philadelphia Bureau of Highways.

**Another Defeat for Municipal Ownership of Water Works** took place at Des Moines, Iowa, on June 1, when the people voted 6855 for to 4107 against the issuance of $2,380,000 for water-works purposes, the understanding being that the plant of the Des Moines Water Co. was to be bought. Although there was a large majority in favor of the bonds the proposition did not carry because the state law requires that the number of affirmative votes at such an election must be greater than 50% of the total number voting at the last preceding general city election. In this case about 12,600 affirmative votes were required to carry the bonds. As noted in our issue of Apr. 23, 1914, p. 935, the people of Des Moines voted in favor of buying the property of the company on Mar. 30, 1914. At the same time they also voted by a heavy majority in favor of the necessary bond issue, but on this proposition the vote was light (through an alleged misunderstanding) and the requisite percentage of affirmative votes based on the preceding general municipal election was not cast. We are indebted to Charles S. Denman, General Manager of the Des Moines Water Co., for the figures given above.

**The General Manager of Big Rapids, Mich.,** appears to have more comprehensive powers than those given to most city managers. Through the courtesy of C. E. Chappell, who was recently appointed General Manager of Big Rapids, we are enabled to give the following extract from the city charter of that city:

Sec. 1. The General Manager shall be charged and instructed with the following duties, powers and responsibilities, subject to the direction of the Commission.

First—The management, supervision and control of the City Water-Works.

Second—The management and supervision of the Sewers, Sewage System and drainage of the City.

Third—The supervision of the Highways, Streets, Sidewalks, Alleys and Bridges within the City.

Fourth—The supervision and direction of the City Fire Department and the care of the Fire Engines, Apparatus and property.

Fifth—He shall be City Marshall, Chief of Police and Fire Warden.

Sixth—He shall be City Surveyor, and shall have same powers within the City as are conferred by law upon County Surveyors.

Seventh—The supervision of such other improvements and works as the Commission may place under his management and control.

Sec. 2. It shall be the duty of the General Manager to appoint all necessary Engineers, Assistant Marshals, Nightwatchmen, Assistant Chiefs of Fire Department, Firemen, etc., all subject to the approval of the Commission.

Sec. 3. His term of office shall be one year and until his successor is appointed and qualified.

**The Authority of the Interstate Commerce Commission** over intrastate railway rates wherever in conflict with interstate rates and commerce was sustained by the U. S. Supreme Court in the so called Shreveport case (Houston East & West Texas, Houston & Shreveport, and Texas & Pacific Rys. vs. Interstate Commerce Commission). The Interstate Commission some two years ago ordered these three roads to equalize certain freight rates westward from Shreveport int oTexas with interstate rates from Dallas eastward in spite of an order of the Texas Railroad Commission making low rates. The Interstate Commission order was sustained by the Commerce Court in 1913. The following sentences from Justice Hughes' opinion are of interest:

We are not unmindful of the gravity of the question that is presented when the state and federal views conflict, but it was recognized at the beginning that the nation could not prosper if interstate and foreign trade are governed by many masters, and, where the interests of the freedom of interstate commerce are involved, the judgment of Congress and of the agencies it lawfully establishes must control.

Wherever the interstate and intrastate transactions of carriers are so related that the government of the one involves the control of the other, it is Congress, and not the state, that is entitled to prescribe the final and dominant rule, for otherwise Congress would be denied the exercise of its constitutional authority, and the state, and not the nation, would be supreme within the national field.

That an unjust discrimination in the rates of a common carrier, by which one person or locality is unduly favored as against another under substantially similar conditions of traffic, constitutes an evil is undeniable; and where this evil consists in the action of an interstate carrier in unreasonably discriminating against interstate traffic over its line, the authority of Congress to prevent it is clear.

Having this power, Congress could provide for its execution through the aid of a subordinate body, and we conclude that the order of the commission now in question cannot be held invalid upon the ground that it exceeded the authority which Congress could lawfully confer.

## PERSONALS

Mr. Charles Saxton, Assistant Street Commissioner of St. Louis, Mo., has been appointed Superintendent of Garbage Removal at a salary of $2400 per annum.

Mr. Edward Gies, formerly City Engineer of Waukegan, Ill., has been appointed Engineer in charge sewers at Plano, Ill., where a large new sewer system is being constructed.

Mr. Allan Wallace, formerly connected with the traffic department of the Grand Trunk Ry., has been appointed Traffic Manager of the H. W. Johns-Manville Co., New York City.

Mr. Emory Sudler, Assoc. M. Am. Soc. C. E., Engineer in charge of the Gunpowder Improvement Division of the Baltimore City Water Department, Baltimore, Md., has resigned, effective July 1.

Mr. M. B. Lambert has been appointed Assistant Manager of the railway and lighting department of the Westinghouse Electric & Manufacturing Co., Pittsburgh, Penn., in charge of the sales work of the department.

Mr. J. C. Stevens, M. Am. Soc. C. E., recently Engineer of the Ebro Irrigation & Power Co., Ltd., Barcelona, Spain, has returned to this country and has resumed his practice as Consulting Engineer, 605 Spalding Bldg., Portland, Ore.

Mr. C. P. Dexter, of the County Engineer's office, Seattle, Wash., has been appointed an Assistant Engineer, Alaska Engineering Commission. Survey work for the new railway in Alaska has already been commenced, according to recent press dispatches.

Mr. Harvey W. Bell, founder of the Bell Locomotive Works, Inc., Yonkers, N. Y., has accepted a position with the H. K. Porter Co., Pittsburgh, Penn., where he will specialize in the manufacture of a gasoline-steam locomotive for mining and tunnel work.

Mr. E. P. Dillon, Assoc. Am. Inst. E. E., for several years with the Westinghouse Electric & Manufacturing Co., Pittsburgh, Penn., has been placed in charge of the commercial end of the railway and lighting department of the company with the title of Assistant Manager.

Mr. L. K. Sherman, M. Am. Soc. C. E., Engineer and Contractor, Chicago, Ill., has been appointed by Governor Dunne a member of the Illinois Rivers and Lakes Commission. He succeeds Mr. Walter A. Shaw, Civil Engineer, also of Chicago, who some months ago was appointed a member of the new Illinois Public Utilities Commission.

Mr. R. J. Harding, M. Am. Soc. C. E., Chief Engineer of the San Antonio Water Supply Co., San Antonio, Tex., has been made Vice-President and General Manager of the company to succeed Mr. C. H. Surkamp, Jr., resigned. Mr. Harding is a civil-engineer graduate of Cornell University, class of 1903, and was formerly Consulting Engineer at Poughkeepsie, N. Y.

Mr. F. E. Pierce, M. Am. Soc. C. E., has resigned as Chief Engineer of the New Jersey Zinc Co., in whose employ he has served for 15 years, and has opened an office at 35 Nassau St., New York City, as Consulting Engineer. Mr. Pierce is a graduate of the Columbia University School of Mines, class of 1892, and is a member of the American Society of Mechanical Engineers and the American Institute of Mining Engineers.

Messrs. Harrison Smith, Assoc. M. Am. Soc. C. E., and G. C. See, Jun. Am. Soc. C. E., announce the partnership of See & Smith, Civil Engineers, Temple, Tex. They will specialize in highway engineering. Mr. Smith has recently been connected with hydro-electric work in Alabama and Mr. See has recently resigned as Assistant Engineer, New York State Highway Department, with which he had been connected for the past six years.

Dr. Harold Pender, M. Am. Inst. E. E., Professor of electrical engineering at the Massachusetts Institute of Technology, has resigned to become Professor-in-charge of the department of electrical engineering at the University of Pennsylvania. The departments of mechanical and electrical engineering have been under the joint direction of the Whitney Professor of dynamical engineering. Next fall the department of electrical engineering will be on an independent footing.

Mr. Frederick A. Scheffler, F. Am. Inst. E. E., has been elected President of the New York Electrical Society. Mr. Scheffler was associated with Mr. Thomas A. Edison in 1881 and has since been General Superintendent of the Pittsburgh, Penn., works of the Westinghouse Electric & Manufacturing Co., of the Brush Electric Co., Cleveland, Ohio, and Manager of the Watsessing, N. J., factory of the Sprague Electric Co. He is now connected with the Babcock & Wilcox Co., Bayonne, N. J.

Mr. Charles H. Wright, M. Am. Soc. C. E., former Chief Engineer of the Brown Hoisting Machinery Co., Cleveland, Ohio, has been appointed City Engineer of Rialto, Calif., where he has been settled for the last three years. Mr. Wright is a civil-engineering graduate of the Worcester Polytechnic Institute, class of 1879, and was connected with the Brown Hoisting Machinery Co. for many years, and is the inventor of much of the company's coal- and ore-handling machinery. He retired from active practice about three years ago and has since made his home in California.

Mr. William Henry Finley, M. Am. Soc. C. E., former Assistant Chief Engineer of the Chicago & Northwestern Ry., has been promoted to be Chief Engineer, succeeding Mr. E. C. Carter, M. Am. Soc. C. E., whose resignation was noted in our issue of last week. Mr. Finley was born in Delaware and educated in the public schools of Wilmington, Del. His engineering experience began with the Edgemoor Iron Co. in Wilmington in 1881. After six years' experience here he entered the bridge and building department of the Chicago, Milwaukee & St. Paul Ry., where he remained until 1892, when he was appointed Engineer of Bridges of the Chicago & Northwestern Ry. He was successively promoted to be Principal Assistant Engineer and Assistant Chief Engineer. Mr. Finley is a Past-President of the Western Society of Engineers.

Mr. Henry N. Ruttan, M. Am. Soc. C. E., City Engineer of Winnipeg, Man., for nearly 30 years, has been retired on a pension. He will also be retained by the city as Consulting Engineer. Mr. Ruttan's engineering experience dates from 1866 when he joined the engineer corps of the Grand Trunk Ry. Later he was with the engineering staffs of the Intercolonial Ry. and the Canadian Pacific Ry. His work on the Canadian Pacific Ry. was in the West and in 1880 he took up his residence in Winnipeg, where for several years he was in private practice as a Civil Engineer. In 1886 he was appointed City Engineer and has ever since held that position. Mr. Ruttan is a member of the American Society of Civil Engineers, the Institution of Civil Engineers of Great Britain, of the Canadian Society of Civil Engineers, of which he was President in 1910, and of the American Institute of Consulting Engineers.

Mr. Frank H. Alfred, M. Am. Soc. C. E., General Manager of the Pere Marquette R.R., Detroit, Mich., has been appointed Chief Executive Officer for the receivers, succeeding Mr. W. A. Garrett, resigned. Mr. Alfred obtained his technical education at the University of Michigan and Ohio State University. His first engineering experience was as a rodman with the Columbus, Lima & Milwaukee R.R. in 1887. Later he was Resident Engineer on construction. He was Assistant Engineer of the Norfolk & Western Ry. from 1889 to 1894. From 1894 to 1900 he was successively Assistant to the Chief Engineer of the Hocking Valley Ry., Engineer of Maintenance-of-way of the Cleveland, Akron & Columbus R.R., and of the Wheeling & Lake Erie R.R. He was Assistant Engineer of the Pere Marquette R.R., 1900 to 1902, and Chief Engineer, 1902 to 1905, when he resigned to become Manager of the Canadian White Co., Ltd., of Montreal, Que. Mr. Alfred was appointed Assistant to the President of the Cincinnati, Hamilton & Dayton Ry. in 1908, was General Superintendent until 1912, when he returned to the Pere Marquette R.R. as Assistant General Manager.

## OBITUARY

John P. Harbison, for nearly 50 years President of the Hartford (Conn.) City Gas Light Co., died June 5, at his home in Hartford. He was a prominent gas engineer.

Thomas Dolan, a Philadelphia financier, for many years President of the United Gas Improvement Co., of Philadelphia, died June 12. He was born in Pennsylvania, Oct. 27, 1834.

H. J. Hibert, former City Engineer of Milwaukee, Wis., and a pioneer Western railway engineer, died June 10, aged 84 years. He also served in various other public offices in Milwaukee.

W. J. Sutton, M. Am. Inst. M. E., a graduate of the Michigan College of Mines and instructor in mineralogy there from 1896 to 1898, died May 9, at Vancouver, B. C. He was born in Kincardine, Ont., in 1859.

Edward G. Brill, Vice-President and Treasurer of J. G. Brill & Co., and the last of the four sons of the founder of

the car works at Philadelphia, Penn., died at his home in Atlantic City, N. J., June 7, aged 63 years.

William Armstrong, a pioneer Canadian engineer, died at his home in Toronto, Ont., June 9, in the 92nd year of his age. He was born in Dublin, Ireland, and served as an apprentice and draftsman on English railways before coming to Canada in 1851. He was subsequently employed by the Grand Trunk Ry. as a designer.

D. K. Colburn, Assistant General Manager in charge of engineering of the Sunset Central Lines of the Southern Pacific Co., at Houston, Texas, died at Woodhull, Ill., June 3, at the age of 68 years. Mr. Colburn had been connected with the engineering and bridge and building departments of the Sunset Central Lines for 25 years.

G. E. Tower, Chief Engineer, U. S. N., retired, died June 9, at his home in Washington, D. C. He was born in Ohio in 1836 and served several years as a steam engineer on lake steamers. At the beginning of the Civil War he was commissioned Third Assistant Engineer in the navy, and took part in many battles. He was promoted to be Chief Engineer in 1887 and retired in 1897.

Alexander Stewart, M. Can. Soc. C. E., Assistant Chief Engineer of the Great Northern Ry., Seattle, Wash., died at his home in that city June 6. He was born at Dalhousie, N. B., Apr. 23, 1854, and educated at the University of New Brunswick. His railway experience was begun in 1874 as a leveler on the Prince Edward Island Ry. For several years he was Assistant Engineer of Canadian railways and from 1880 to 1882 was Deputy Surveyor of New Brunswick. In 1882 he was appointed Division Engineer on construction of the Canadian Pacific Ry. Two years later he resigned to become Assistant Chief Engineer of the Alberta Railway & Coal Co. In 1885 he was Engineer in charge of construction of the Manitoba & Northwestern Ry., and for three years following was Chief Engineer of Railways for the Manitoba Government. Mr. Stewart was Chief Engineer of the Calgary & Edmonton Ry. in 1889 and 1890, and Chief Engineer of the Duluth & Winnipeg Ry. from 1890 to 1895. Since 1895 he had been with the Great Northern Ry., first as Assistant Engineer, later Resident Engineer at Spokane, and since 1908, Assistant Chief Engineer.

James Campbell, former President of the North American Co., and before that Vice-President of the St. Louis & San Francisco R.R., died June 12, at his summer home at Greenwich, Conn., leaving a fortune estimated at $50,000,000. He was born in Ireland 67 years ago. When two years old his parents came to this country and settled in Virginia. During the Civil War, while a boy about 12 years old, he made the acquaintance of John C. Frémont, who afterward employed him in the engineering department of the Southwest Pacific R.R. For a number of years Mr. Campbell continued in engineering work and became Chief Engineer of the Kansas City, Missouri & Mobile R.R., which later formed a part of the St. Louis & San Francisco R.R. system. According to popular accounts of his career his first financial venture was made in 1873, when he bought up the bonds of a number of counties in Missouri, which were in default. By mortgaging his holdings to the limit, he was able to purchase bonds worth half a million at their face value for prices ranging from 10 to 25c. on the dollar. Railroad building restored prosperity in the state, and he reaped large profits from his venture. Subsequently he invested in and promoted public utility corporations and the St. Louis & San Francisco R.R. He was President of the North American Co., when the receivership was forced upon the St. Louis & San Francisco R.R., and at the time of his death he was a defendent in the United States Government suit against the former officers of the St. Louis & San Francisco R.R. to recover $14,000,000 of the stockholders' money, which the former directors are accused of misusing.

## ENGINEERING SOCIETIES

### COMING MEETINGS

SOCIETY OF AUTOMOBILE ENGINEERS.
June 23-26. Annual convention at Cape May, N. J. Chairman of Arrangement Committee, Arthur B. Cummer, 1790 Broadway, New York City.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
June 23-26. Thirty-first annual convention at Detroit, Mich. Secy., F. L. Hutchinson, 29 W. 39th St., New York City.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.
June 23-26. Annual meeting at Princeton, N. J. Secy., Henry H. Norris, 29 W. 39th St., New York City.

AMERICAN SOCIETY FOR TESTING MATERIALS.
June 30-July 3. Seventeenth annual meeting at Atlantic City, N. J. Secy., Edgar Marburg, University of Pennsylvania, Philadelphia, Penn.

AMERICAN SOCIETY OF ENGINEERS, ARCHITECTS AND CONSTRUCTORS.
July 3-4. Convention at Brighton Beach, L. I. Secretary, T. Hugh Boorman, 35 W. 39th St., New York City.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.
July 9-11. Semi-annual meeting at Cleveland, Ohio. Secy., J. J. Blackmore, 29 W. 39th St., New York City.

OHIO ELECTRIC LIGHT ASSOCIATION.
July 16-19. Annual convention at Cedar Point, Ohio. Secy., D. L. Gasgill, Greenville, Ohio.

AMERICAN ASSOCIATION OF RAILROAD SUPERINTENDENTS.
Aug. 20-21. Annual meeting in New York City. Secy., E. H. Harman, Room 101, Union Station, St. Louis, Mo.

AMERICAN PEAT SOCIETY.
Aug. 20-22. Annual meeting at Duluth, Minn. Secy., Julius Bordollo, 17 Battery Place, New York City.

**Association of Edison Illuminating Companies**—The 1914 convention of the Association will be held at White Sulphur Springs, W. Va., with headquarters at the Greenbrier Hotel, Sept. 14-17. About twelve general papers and ten committee reports will be presented. The usual outdoor sports will be available.

**International Association for Testing Materials**—The Seventh Congress of the International Association for Testing Materials will be held in St. Petersburg, Aug. 12-17, 1915. Four days will be devoted to the discussion of problems on testing materials. Extensive excursions into the interior of Russia have been arranged, to follow the close of the Congress.

**Southern California Association of Members of the American Society of Civil Engineers**—A dinner at Hotel Clark, Los Angeles, at which Sir William Willcocks was the guest of honor, was held on June 5. President J. B. Lippincott presided. Col. Holabird, who has charge of the Imperial Canal made a few remarks on the Colorado River. William Mulholland then introduced the visitor, who made a general address.

**New England Water-Works Association**—The June outing will be held on June 24 at Worcester, Mass. An inspection trip will be made to the Pine Hill reservoir of the Worcester water supply, now under construction. Expenses at Worcester will amount to $2 per capita. The Committee of Arrangements is composed of George W. Batchelder, John Doyle and Willard Kent. The secretary is situated at 715 Tremont Temple, Boston, Mass.

**International Association of Fire Engineers**—Among the topics which will be discussed at the 42d annual convention will be the following: "Automobile Fire Stations," A. S. Aungst. "The Best Way to Prevent Fires," H. F. Magee, "Protection of Water Fronts; the Necessity and Efficiency of Fire Boats," by T. A. Clancy. "Has the Gasoline Pumping Engine Come to Stay?" Edward F. Dahill. Another subject open for discussion is whether fire hydrants should be used for purposes other than extinguishing fires. There will be the usual tests of pumping engines.

**Pacific Northwest Society of Engineers**—The 12th annual convention will be held June 19-20, at Seattle, Wash., with headquarters at the Frye Hotel. The first day will be devoted to business sessions and the usual informal dinner. In the afternoon Floyd W. Allen, Deputy County Engineer, will read a paper on the "Construction of County Roads." Following the dinner Charles H. Swigart, Supervising Engineer, U. S. Reclamation Service, will deliver an illustrated address on storage problems in the Yakima Valley. On June 20 an excursion will made to Lake Keechelus Dam, now under construction by the U. S. Reclamation Service, at Oak Creek, Wash.

**Cleveland Engineering Society**—At the 34th annual meeting and banquet of the Society held on June 9 at the University Club, 266 members and guests were in attendance. William O. Henderer, toastmaster and retiring president, reviewed the progress of the Society during the past year. New members to the number of 211 were enrolled during the year, making the total membership 741. The steady growth of the Society and its flourishing condition is laid to the active interest in its affairs taken by a large number of members. The principal speaker and guest of the evening was Charles Whiting Baker, Editor-in-Chief of "Engineering News," who spoke on "Ethics for Engineers." Dr. A. B. Meldrum, the pastor of Old Stone Church and President-Elect E. H. Whitlock were the other speakers. At the speakers' table sat three charter members of the Society: Hosea Paul, County Recorder, Walter P. Rice, formerly City Engineer and C. H. Burgess, formerly County Surveyor.

# Engineering Literature

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## REVIEWS AND NOTES

### Two Notable Books on Foundations

REVISED BY C. S. RINDSFOOS*

FOUNDATIONS OF BRIDGES AND BUILDINGS—By Henry S. Jacoby, Professor of Bridge Engineering, Cornell University, and Roland P. Davis, Professor of Structural and Hydraulic Engineering, West Virginia University. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. xvi + 603; 205 text illustrations. $5, net.

A PRACTICAL TREATISE ON SUB-AQUEOUS FOUNDATIONS, Including the Coffer-Dam Process for Piers and Dredges and Dredging, With Practical Examples from Actual Work—By Charles Evan Fowler, M. Am. Soc. C. E., Special Lecturer, University of Washington. Third edition, revised and enlarged. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 6x9 in.; pp. xliii + 814; 477 illustrations. $7.50, net.

An examination of "Foundations of Bridges and Buildings" makes it evident that it was written primarily for use as a textbook for students and young engineers. Although treated fairly exhaustively, each subject is begun in an elementary manner and developed so as to presuppose no knowledge of the subject on the part of the reader. For example, the book abounds in such clauses as:

> A structure usually consists of two parts, one of which is supported by the other; the upper part being known as the superstructure and the lower part as the substructure. * * * * A pile driver is a machine for driving piles. * * * * a coffer-dam is a temporary structure used for the purpose of excluding the water from a given site, or area, either wholly or to such a degree that with a reasonable amount of pumping the permanent substructure may be built within it in the open air, or that other work may be accomplished.

However, having once developed any given topic, there is given a considerable amount of matter of interest to the practical engineer.

The book is of convenient size and contains numerous well chosen and excellently reproduced photographs illustrate the text. There is also appended a very complete bibliography, pertaining to the same subjects.

The first third of the book is devoted to piles and pile-driving, since "young engineers are more likely to obtain their early experience with pile foundations than with any other class of foundation construction." Round and sheath piles, of steel, timber and concrete, are discussed, with relation to their properties, their design, the equipment for driving and methods used. One chapter is devoted to the underpinning of buildings, one chapter to the bearing capacity of soils and practically the entire balance of the book to caissons, coffer-dams and the design and building of piers and footings. Very little of an historical nature is included and very little in the way of direct quotations from current technical magazines.

The book is quite accurate in essentials. The examples of actual practice which are mentioned are to be commended, inasmuch as they are mostly well known works of recent date and well suited to the rest of the contents.

Some of the items which are discussed, and which add considerably to the value of the volume, are concrete piles, steel sheet piles, physiological effects of compressed air and prevention of caisson disease, various methods of constructing deep open wells for buildings, design of steel grillage, shoring and underpinning buildings, and test boring. These items are mentioned as they are not so universally found in other books on foundations.

On the other hand, the book does not go extensively into the detail of the application of piles to piers and docks. Very little is said of diving, of the use of explosives or of quarrying. No information is given on floating equipment or details of contractor's machinery, such as tugs, scows, pumps, engines, dredges, buckets, etc. Neither is stress laid on methods of estimating cost. However, it was more desirable to omit these subjects than to have issued an unwieldy volume. The writer looks forward to the day when a more complete treatise on sub-aqueous work, than has yet been written, will be issued in several volumes. It is as impossible to tell all under one cover as it would be to confine an entire treatise on civil engineering within the limits of five or six hundred pages.

Briefly then, it may be said that "Foundations of Bridges and buildings" is essentially a book for the classroom. It is well written, systematic and accurate.

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In his preface to a "Practical Treatise on Sub-Aqueous Foundations," Mr. Fowler says:

> The necessity for revising the text for a new edition of "Ordinary Foundations," by the same author, caused a general review to be made of the literature on this subject and disclosed the fact that there was need for a more extensive treatise than had yet appeared on the subject.

There is no doubt but that the available literature on this subject, in book form, is absurdly small. The technical papers have from time to time recorded the methods and equipment used in the construction of the most

*Secretary-Treasurer, The Foundation Co., Woolworth Bldg., New York City.

important works, but very few attempts have been made to gather together, in one volume, the most typical examples in order to render them easily available to the student and engineer. To be of the greatest service, a book of this character should be systematically arranged with regard to the methods employed. Moreover, each example from actual experience which is chosen should be the best available to illustrate any given method, and due weight should be given to the fact that examples near at home and of recent date are of most interest. How well the author has succeeded in this instance can be judged from the following notes.

The "Practical Treatise" is a rather ponderous volume of 33 chapters and 800 pages. The size alone will operate against its popularity as a college textbook. Its size will not add to its popularity with the practical engineer. It would have been advisable to have issued the work in two volumes or else to have used thinner paper. There are approximately five-hundred line and halftone cuts. The halftones are almost without exception indistinct and decidedly below the standard of the rest of the volume. Here again, a different grade of paper would have produced a much better effect. Nothing so adds to the usefulness of a technical book as good illustrations. Nothing is more confusing than an illustration which leaves everything to the imagination.

The book is appropriately begun by devoting the first chapter to a brief description of several of the earliest engineering works of history. Then follow two chapters on crib coffer-dams; four on piles and pile driving; five on cylinders and caissons, both open and pneumatic; one on diving; one on the removal of old piers; four on pumping and dredging; and one chapter on floating equipment. In other words, the first half of the book has to do with what is usually the preliminary part of foundation work, the part that is done before any permanent installation can be begun. The second half of the book contains 14 chapters devoted to the character of soils and their bearing capacity; the location and design of piers, walls and footings; the method of obtaining and using rock fill; the calculation of piers, footings and retaining walls; the properties of cement and concrete; the construction of timber piers and wharves and methods of preserving timber; the foundations of seawalls, dams, breakwaters, docks and locks; the design of concrete forms; and finally methods of estimating costs and cost statistics. In addition, there are 11 appendixes giving standard or typical specifications on such things as cement, masonry, steel piling, etc.

It will be seen that there is very little in the realm of underground construction which has not been considered and a great deal that might not be expected to be included. For example, the chapters on dredges, scows and tug boats are as unexpected as they are worth while. The chapter devoted to concrete forms is admirable. Also, the chapters dealing with costs will be helpful if properly used. The author is aware of the necessity of the intelligent use of these statistics, inasmuch as he says:

> If unit costs of labor are used from old data, they must be employed with fear and trembling and only by bringing to bear to the fullest extent the estimator's judgment. Where the unit costs are based on work executed by the person using them, and used on a new piece of work, there is a chance for the judgment to be good, but if such is not the case, some data may have been omitted from another's record which will make it impossible to form a correct judgment.

No mention is made of tunnel and subway construction, which often are subaqueous and closely related to foundation work. No mention is made of shoring, underpinning and moving of buildings, although they constitute an important consideration in the building of many deep city foundations. The sinking of mine shafts might also appropriately have been included.

The method used in presenting the subject of piles and pile driving gives a fairly representative idea of the method employed in the case of each of the other subjects enumerated. The early use of piles and the development of the piledriver are first taken up. Details of modern driving outfits, including leads, steam hammers, scows and pulling rigs, are then given. The properties of piles, both wooden and concrete, are discussed. The jetting of piles and considerable detail regarding the pumps and boilers required for the jetting come next, followed by some practical examples where sheet and round piling have been used. Interspersed all through are bits of philosophy, practical information and technical formulas, which the author apparently accumulated during a number of years' association with engineering construction. In fact the author states in the preface "but little has been recorded as to the experience of others, and the methods used by the author can be easily and intelligently modified for any particular case." Indeed, the book might appropriately have been entitled the authors' "Thesaurus of Engineering Fact and Formula." This is at once the strength and weakness of the volume. The many bits of advice, of caution and of simple narrative, take one out of the realm of the academic. The recital, first hand, of difficulties overcome, of expedients used and work accomplished, lend encouragement to those confronted by similar difficulties. Then, too, advice which undoubtedly is from the author's own experience, has, at times, a directness that would not be found in a book which is all theory. For example, in one place, the author says:

> When for some reason the necessary care was not exercised in the construction of a coffer-dam and in puddling it, or where there were discovered conditions not known before the construction began, which rendered the work unsatisfactory or leaky, it will usually be found that the mode of repair which seems most expensive will in the end prove the cheapest and the most expeditious. If the puddle proves leaky, and it be decided that the material was of too porous a nature, the best remedy is to dig out and replace it with better.

How many times has it not happened that the engineer balancing in his mind the reasons for and against a radical move, would be encouraged to do the heroic, though more expensive thing, by reading these words.

On the other hand, by limiting the book to the author's personal experience, many better examples of work are omitted. Operations of our present day could, in many instances, have been substituted to advantage for those which have been cited and which were conducted twenty or more years ago. Furthermore, there is a total lack of reference to some developments which have occurred outside the author's experience. This is no criticism of the author, as no man could be expected to have had actual experience with the latest development in each department of underground work. For example, timber caissons which were used so extensively several years ago, and still are in river work, are fairly well described. Nothing is said of the extensive use of reinforced-concrete pneumatic caissons for city building foundations.

The so called "Chicago method" is omitted. The righting of structures which have settled out of plumb and substitution of new and adequate foundations, of which there are notable examples, is not mentioned. The avoidance of pumping direct in pier holes by "general pumping," the freezing process for deep shafts, the conveyance of concrete by compressed air or gravity—these and many other items, in the estimation of the reviewer, should have been given space in preference to the many tables from catalogs and handbooks which are already quite available.

In conclusion, it is the writer's belief that the "Practical Treatise" is as good as any book that has appeared on the subject and better than any for the practical engineer's use, though not adapted for the classroom. That, while it contains a considerable quantity of superfluous and antiquated material copied from technical papers, which could be replaced with better and more modern examples, and while there are several subjects omitted entirely, it is, nevertheless, 90% good, and a valuable addition to engineering literature.

## Modern Water-Supply in Densely Populated Districts in Germany

REVIEWED BY E. KUICHLING*

NEUZEITLICHE WASSERVERSORGUNG in Gegenden Starker Bevölkerungs-Annäufung in Deutschland—Von Dr.-Ing. A. Heilmann, Regierungsbaumeister. München and Berlin: R. Oldenbourg. Paper; 7x10 in.; pp. viii + 160; 21 illustrations. 5.50 Marks.

The author presents in compact form much information about the growth of population in the 43 largest cities of the German Empire; the water-supply and per capita consumption for domestic and industrial uses therein from 1888 to 1911, along with the decennial increase or decrease in the total per capita consumption; the costs of these water-works in the years 1890, 1900 and 1910, and the costs per capita; and the financial statistics of income, operating expense and fixed charges relating to them in the year 1911. He also discusses in detail the subjects of the quality and quantity of the supply, and whether it should be furnished by the city, by a private corporation, or jointly by both, or by an association of municipalilties; the respective merits of ground-water and surface-waters, together with the necessary storage and treatment of the latter; and the proper method of computing the cost of delivering the water and the price at which it is to be sold to the consumers.

The growing tendency of people to congregate in cities is indicated by the fact that in 1871 only 26% of the population of the German Empire was urban, whereas in 1900 the proportion rose to 42% and in 1910 to 60%. This great increase is due to the development of industries, and associated therewith is a corresponding increase in the quantity of water used for both domestic and industrial purposes.

In many places the old sources of supply have proved inadequate and strenuous efforts are being made to enlarge their yield. Ground-waters are augmented artificially by diverting or pumping roughly prefiltered river water upon suitable land and allowing it to percolate very slowly through the natural soil. The water thus produced is generally regarded as being better than the effluent from any artificial filter, on account of the much longer time it remains in the ground before reaching the wells. Where sufficient ground-water is not available, surface waters are stored in large reservoirs for use during the dry season. The data for 15 such reservoirs built since 1890 are given in a table from which the following figures are deduced by the writer:

| | Maximum | Minimum | Average |
|---|---|---|---|
| Drainage area, in sq. miles | 9.46 | 0.33 | 3.98 |
| Storage capacity, in million U. S. gal. | 1,585.1 | 30.9 | 531.6 |
| Storage capacity per sq. mile, in million gal. | 353.9 | 16.8 | 137.2 |
| Cost of reservoir, including land | $1,536,000 | $122,400 | $387,912 |
| Cost of reservoir, per million gal. | $2,477.10 | $340.68 | $729.71 |

Dual systems of supply, of which one delivers impure water, are not in favor, owing to the danger of making mistakes for drinking. The maximum daily consumption in a number of the cities in the year 1911 was from 40 to 50% greater, and the minimum from 30 to 40% less, than the average throughout the year. The largest average daily consumption per capita in 1910 was 72 U. S. gal., in Bochum, and the smallest was 8.5 gal., in Plauen. The average price of the water delivered to consumers in 41 of the said large cities ranges from a maximum of 25.8c. per 1000 gal. in Wiesbaden, to a minimum of 3.27c. in Augsburg, the mean being 13c. Much attention is given by the author to proper accounting, thus making his book a valuable contribution to the financial management of large water-works.

## Compressed Air

REVIEWED BY H. F. HALLADAY*

COMPRESSED AIR: A Treatise on the Production, Transmission and Use of Compressed Air—By Theodore Simons, M. Am. Inst. M. E., Professor of Mining Engineering, Montana State School of Mines. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. xi + 173; 42 illustrations. $1.50, net.

In his preface the author states of his book:

> The contents are intended to give the student and the general reader such an insight into the natural laws and physical principles underlying the production, transmission and use of compressed air as shall enable him to comprehend the operation of the various appliances employed for this purpose and to judge of their merit.

The book is divided into four parts: Parts 1 and 2, on the production and transmission of compressed air, are well written. They contain problems which are carefully worked out and which serve to familiarize the student with actual quantities and the application of the formulas.

Part 3 is entitled "The Use of Compressed Air." The reader would naturally infer that it would cite a number of instances where compressed air is, or might be used. This is not the case. Chapters XII to XVI inclusive treat of the theory of the use of compressed air and cover Theory of Air Engines, Losses, Efficiency of a Compressed Air System, Reheating, etc. The formulas given in these chapters are also illustrated by examples.

Part 4 describes and illustrates a few prominent types of compressors and accessories. Different types of inlet and exhaust valves are shown and mention is also made of automatic regulators. For use as a textbook the author showed good judgment in not devoting more space to different forms of manufactured compressors since this information can be found in catalogues of the various compressor manufacturing companies. An Appendix of nine useful tables concludes the book.

Throughout this work the author has made use of

*52 Broadway, New York City.

*1134 Boyd St., Watertown, N. Y.

graphical illustrations of adiabatic and isothemal compression. Actual cards from single as well as two-stage compressors are shown and analyzed. Although the author has not given to the reader anything new, yet the information is well arranged for the student and the book, supplemented by class-room lectures, should form a thorough course in compressed air for the young engineer.

## Public-Utility Laws

A TREATISE ON THE LAW OF PUBLIC UTILITIES OPERATING IN CITIES AND TOWNS—By Oscar L. Pond, Member of the Indianapolis Bar; author of "Municipal Control of Public Utilities." Indianapolis, Ind.: The Bobbs-Merrill Co. Cloth; 6x9 in.; pp. lvi + 954. $6.

ILLINOIS PUBLIC UTILITY COMMISSION LAW AND MUNICIPAL OWNERSHIP LAW, With Annotations, Marginal Notes and Index-Digest—By William J. Norton, Secretary of the Rate Research Committee of the National Electric Light Association. Chicago: T. H. Flood & Co., 214 W. Madison St., and Electrical Review Publishing Co., 608 So. Dearborn St. Linen; 8x11 in.; pp. 200. $2, net, postpaid.

Dr. Pond's book is a general treatise on public utilities from the lawyer's viewpoint and in law-report form. It deals rather disjointedly with such matters as municipal corporations, municipal charters, "municipal purposes," franchises, liabilities, privileges, rights to fix rates, reasonable regulation, valuations, municipal ownership, municipal control, state supervision. Such presentation of discussions necessarily differs from dissertations which might be made from the engineer's point of view.

For instance, in discussing contracts to exclude competition, a New York case is cited in which the court holds that two telephone companies in a town are a benefit (on the theory that "one system will never be made to reach all subscribers as cheaply as would be the case if the possibility of competition were destroyed) and that a contract for exclusive service is invalid. There is no comment here but some four hundred sections farther along the fallacy of competition in natural monopolies is exposed.

Under "municipal ownership" the reader gets the impression that failure of regulation necessitates municipal ownership and that this best conserves public interest. Yet under "municipal bureaus" the opposite impression is given—that the institution of a nonpartisan and permanent regulating commission gives a business-like handling to purely business matters, secured in no other way. The author frankly admits that cases coming before such commissions are business matters not best settled by court procedure.

Evidently the author has endeavored to present the state of judicial opinion and economic thought on the great variety of topics mentioned. In some instances the logical and illogical are not labeled and then the special pleader can find something to support his case whichever side he takes.

The engineer searches in vain for illumination of a few such points as court attitudes on long-time sinking funds for utilities. However, the volume is ponderous without the pursuit of such ultimate details (which nevertheless, often become of controlling importance to the engineer); the citations are numerous and evidently comprehensive. For that reason alone the book becomes of importance to the utility engineer.

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Mr. Norton presents an annotated copy of the recent Illinois public-utility laws. Naturally, it is of greatest service to those dealing with Illinois utilities. There is first an index giving references to various provisions in the order that an engineer would expect—powers and duties of commission, utility, municipality, public; court procedure; penalties, etc. After that the utility law and the municipal ownership law are reprinted, with the addition of footnotes showing many of the probable sources of the various provisions (in earlier laws of other states). The footnotes also comment on the statute and on practice under other statutes of other states. The utility of such a work as this is obvious.

## A School Text on Electric Machinery

CONTINUOUS AND ALTERNATING CURRENT MACHINERY: An Elementary Textbook for Use in Technical Schools—By J. H. Morecroft, Assistant Professor of Electrical Engineering, Columbia University. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. [Wiley Technical Series.] Cloth; 5x8 in.; pp. ix + 266; 288 text illustrations. $1.75, net.

Prof. Morecroft explains that his book has been written for school use (for industrial, technical-high and engineering schools) which explains the rather more academic approach to the subject than is seen in the earlier and supporting texts of the same series of this publisher—for instance Timbie's "Elements," "Essentials" and "Exercises." Common effects of current are described briefly first and followed by an outline of direct-current phenomena. From the start the mathematical shorthand notation is employed for most concise statement of natural laws. The real mathematical processes involved, however, are quite elementary and this presentation should be easily accepted by even young students and also by older "practical" men who have approached the subject through such books as mentioned above. After this introductory matter on general theory (limited to direct currents) the author announces consideration of direct-current (he prefers the term "continuous-current") and alternating-current apparatus separately and in that order. The following four chapters (170 pp.) show up the former and the next six (170 pp.) are devoted to the latter. Four chapters (85 pp.) take up miscellaneous allied topics like rectifiers, auxiliaries, operation, etc.

Commercial designs (mechanical and electrical) of direct-current machinery are pictured and described under the divisions of (1) field frames; (2) armature cores; (3) commutators; (4) brushes and rigging; (5) field windings; (6) armature windings. The diagrams are original and the halftones are catalog cuts for the most part, both well serving for their intended purpose. The several actions in generators and motors are set forth very simply and clearly and seemingly as adequately as possible under the limitations of a very elementary text; this action includes (for generators) voltage variations, commutation, armature reaction, current and voltage characteristics, parallel operation, and (for motors) torque, power and speed characteristics, control, efficiencies, losses, etc.

Before dipping into alternating-current machinery proper, there is given a preparatory chapter on alternating-current theory which shows care and ability in presenting concepts which are ordinarily grasped by younger students with difficulty—for instance vector quantities. If any criticism can be made it is that these inexperienced minds may think from the discussions leading up to phase displacement between voltage and current that by some occult device the current actually trails the voltage

—does not flow until some time after impressing potential; whereas they will be saved later grief if they can be taught from the start that the current is necessarily at any instant dependent on voltage, all possible reaction voltages being included. The features of design, construction and performance of commercial alternating-current apparatus is taken up in a way similar to that noted for direct-current equipment, transformers being naturally included. The final sections on conversion of alternating to direct current, advantages of polyphase power, indicating and control apparatus, handling and faults of machines, measure up to the standard of the other parts.

## Handbook of Electrical Practice

AMERICAN ELECTRICIANS' HANDBOOK: A Reference Book for Practical Electrical Workers—Compiled by Terrell Croft. New York and London: McGraw-Hill Book Co., Inc. Leather; 4x7 in.; pp. 711; 320 text figures. $3, net.

All engineers (not electrical specialists) who have complained that existing electrical handbooks were too much epitomized theory and too little compilation of practical data and details, will welcome this little member of the handbook family to round out their collection. It treats theory very lightly, of course, for this part obviously has been prepared for the "practical man" rather than the engineer.

The appearance of the book is pleasing for it is not a cumbersome volume and the typography is clean and clear. One of the most pleasing features is the illustrating; no "trade cuts" have been admitted and everything is executed with the same technique. A certain appearance of unity is thereby fostered and this has been increased by the way in which the single compiler has handled his material. The book, obviously, admittedly and necessarily is a compilation; the compiler has, in seemingly every case, shown the authority for recommendations not made on his own responsibility. A very wide range of sources is evident.

The contents are assembled under six general divisions (though they are not called "chapters"), the first of which (125 pp.) is labeled "Fundamentals." The author starts off with familiar conversion tables and then explains direct- and alternating-current phenomena by hydraulic analogs; he dips into typical circuits, voltage relations, testing, properties of electrical materials, proper selection of supply systems, layout of distribution circuits and a great variety of things which can hardly be cataloged here.

Similarly in the second section, "Motors and Generators" (125 pp.), the compiler goes from explanations of types to performance data, operating difficulties, motor applications, insurance installation rules, etc. Sections on "Outside Distribution" and "Inside Wiring" follow, the former quite short (70 p.) and latter rather long (190 pp.). Here are set forth approved pole-line and underground-conduit practice; the layout of distribution lines; standard wiring symbols; insurance requirements; properties and dimensions of wiring materials; working methods; bell, alarm, telephone and gas-lighting wiring; the layout of interior service installations, with typical costs; electric-signal work, and an infinite variety of smaller matters.

One whole section (50 pp.) is devoted to alternating-current transformers, giving common connection schemes for single-phase units, describing three-phase units (single-core) "auto" transformers and compensators, constant-current "tubs," presenting insurance rules covering installation, various methods of outside mounting, etc.

The final section (50 pp.) is on "Illumination" and this covers such a variety of things as physiological effects, use of direct and reflected light, tables of economic illumination intensities, photometry and photometric calculations, shades and reflectors, various incandescent and arc lamps, design of interior illumination schemes, street-lighting practice, etc. There is in this section one obvious omission where use only of prismatic glass shades and reflectors is discussed at any length; of course data are not easily available for the several other (and, to some, the more pleasing) kinds of shades to be seen in use—frosted glass, opal, etc., in various sizes and shapes.

## A New Descriptive Geometry

REVIEWED BY ALTON L. SMITH*

DESCRIPTIVE GEOMETRY: Part I, Lines and Planes—By John C. Tracy, Assistant Professor of Structural Engineering, Sheffield Scientific School, Yale University. Part II, Solids—By Herbert B. North, Assistant Professor of Drawing and Descriptive Geometry, Sheffield Scientific School, Yale University, and John C. Tracy. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 10x8 in.; pp. x + 126; illustrated. $2, net.

The elementary principles of descriptive geometry are here presented in 103 problems. A little over half the text is devoted to the point, line and plane, 16 pages deal with projections of the geometric plane figures and solids and the remaining text is given up to developments, sections, tangencies and intersections.

A few years ago, about the only available text for descriptive geometry was that by Prof. Church. For several reasons this was not well adapted to the requirements of modern engineering students. Because of its difficulty and the manner of presentation, many engineers and some teachers advocated the omission of descriptive geometry from the curriculum and by their arguments indicated that they failed to grasp the great importance of the subject to the designing engineer. This importance rests, not so much on the technical applications, as on the training it gives the imagination in developing the power of visualizing and dealing with nonexistent forms in a logical manner. During the past ten years much thought has been given by teachers to the question of more effective presentation and many new texts have resulted.

The one before us introduces three rather unique features. First, the reduction of all solutions to the operations involved in four fundamental problems, namely, finding the traces of a line, rotation of a point about an axis perpendicular to a plane of projection, rotation of a point into a plane about an axis in that plane and finding the line of intersection of two given planes. The second feature is the use of a series of figures instead of one for the successive steps of an illustrative solution, while the third innovation is the three-column arrangement which gives in parallel columns the space solution, or geometry involved, the specific solution, or statement about the drawing, and the drawing itself.

Other features to be noted are that the arrangement of views is that known as third-angle and the designation of the plane of the various projections is by exponential letters, $h$, $v$ and $p$. This is the only rational way to handle these two matters.

The book is well gotten up both in arrangement and il-

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lustrations, and the only criticism to be offered is the lack of a collection of practice problems selected from engineering practice and the rather meager reference to some of the higher branches of the subject. As a guide through an intricate subject it should prove reliable and efficient.

## Calculation of Belt Drives

REVIEWED BY WINSLOW HERSCHEL*

AUS THEORIE UND PRAXIS DES RIEMENTRIEBES mit besonderer Berücksichtigung der "Riementriebe Boesner," D. R. P.: Ein Handbuch zum Gebrauch beim Entwerfen von Treibriemenanlagen für Maschinen-Ingenieure, Betriebsleiter, Fabriktanten und Studierende—Von Fritz Adolf Boesner, Ingenieur in Aachen. Berlin: A. Seydel, Koniggratzerstrasse 31. Paper: 8x11 in.; pp. 75; 17 text figures and 5 tables. 5 Marks.

The method of calculation of belt drives which the author presents is not in general use, although he first published it some 20 yr. ago. It is based on the idea that, for given materials of belt and pulley, the coefficient of friction is not a constant but is dependent upon the ratio of the diameter of smallest pulley to the thickness of belt. If this ratio is known, the ratio of the effective pull to maximum stress may be found from a table, which also contains the correction to be made for effect of centrifugal force.

The Boesner belt drive is an arrangement for obtaining an effective pull which is large in proportion to the maximum stress to which the belt is subjected, by using pulleys on active shafts, instead of idlers, to increase the length of the arc of contact. It is patented in Germany and elsewhere, including the United States.

The extensive investigation of the efficiency of belt and rope drives, made by Prof. Kammerer, is discussed in considerable detail, and the results are compared with the usual theory of Grashof and the new theory of the author. Prof. Kammerer's results are given in tables of figures, instead of in the somewhat less tangible curves in which they are presented in the original report. Mr. Boesner claims that while, according to Prof. Kammerer, the tests confirm the German rules of practice, as formulated by C. O. Gehrckens, in reality they agree much better with the formula here presented. A stress of from 430 to 570 lb. per sq.in. is recommended, and a table of 26 installations is given, some of which proved successful with stresses of this amount, while others, in which the stresses were higher, had to be rebuilt.

The book is well supplied with practical examples giving costs as well as dimensions, and it should be of value to those in charge of the operation or design of belt drives.

CLEAN WATER AND HOW TO GET IT—By Allen Hazen, M. Am. Soc. C. E. Second edition, revised and enlarged. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 5x8 in.; pp. xii + 196; illustrated. $1.50 (6¼ shillings), net.

Books designed, like this one, for intelligent laymen, both officials and plain citizens, and for engineers who have not specialized in the subject treated, serve a most useful purpose—particularly when so well presented as is the volume before us. The present edition has been brought up to date (see our issue of Oct. 17, 1907 for review of the first edition). It is only necessary to say further, for the benefit of those who have not the first edition, that the author first reviews the various classes of water-supplies and then takes up the action of water on iron pipes and "red water troubles." This brings him naturally to water purification, to which he gives a half-dozen chapters, including one on water-purification methods arranged according to the matters to be removed and another on the required sizes of filters and other parts of water-works. There are chapters on water pressures, use and measurement of water, laying out and building works and two chapters on financial aspects, the last one of these dealing with publicly owned water-works.

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## Organization and Management

REVIEWED BY ROSSITER R. POTTER*

FACTORY ORGANIZATION AND ADMINISTRATION—By Hugo Diemer, M. Am. Soc. M. E., Professor of Industrial Engineering, Pennsylvania State College. Second edition, revised, enlarged and reset. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. xv + 378; 174 illustrations. $3, net.

THE PSYCHOLOGY OF MANAGEMENT: The Function of the Mind in Determining Teaching and Installing Methods of Least Waste—By L. M. Gilbreth. New York: Sturgis & Walton. Cloth; 6x9 in.; pp. 344. $2, net.

The first edition of Prof. Diemer's book was published in 1910. Those familiar with this earlier edition will remember it as a book rich in practical working details of means and methods. It is distinguished particularly by the number of printed forms illustrated. These forms cover the system and records of the purchasing, stores, cost, production and planning departments of factory organizations. The forms illustrated and the accompanying text will be of service to the heads of such departments, in any factory which is trying to keep its methods up to date. The four longest chapters, as the book now stands, are those on planning factory buildings, employment and labor problems, the production or planning department, and the cost department. The book as a whole is preëminently one for the general manager or works manager.

In getting out this second edition, the author has apparently gone over the entire book with intelligent care. The material has been rearranged to some extent, some of the original text has been omitted and new matter has been added to cover recent developments. The net result is an increase of about 60 or 65 pages. On account of the shifting of sections of text from one chapter to another in the rearrangement of the book, it would be tedious to enumerate in detail the new matter added. Much of it appears to have been suggested by various recent discussions in the technical periodicals. The additions include one complete new chapter, of nine pages, on industrial finance.

Perhaps the most striking change is the addition of topical headings and numbers to the paragraphs. These headings are in heavy black type and constitute a great improvement. References have been added, at the close of each chapter, to modern books on the chapter subject, and the list of reference books given in the chapter on bibliography has been nearly doubled in length, while about a dozen pages of the book reviews in this chapter have been omitted.

The book has been notably improved in this edition, and it is now even a bigger three dollars' worth than before. In the reviewer's opinion, however, the improvement is scarcely enough to warrant the purchase of the

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second edition by anyone already owning a copy of the first.

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The psychology of management, so the author explains (who by the way should not be confused with Frank B. Gilbreth, of bricklaying fame), means the effect of the mind that is directing work upon that work, and the effect of the undirected and directed work upon the mind of the worker. This is certainly a good broad subject for a book, and one admittedly important. The author's method of treating it, however, appears to be less important than interesting. The book is written chiefly from the standpoint of the psychologist, apparently with the dual purpose of interesting industrial managers in psychology and interesting students of psychology in the subject of "scientific management." The reader who is of a practical turn of mind and familiar with the current literature and principal works on "scientific management," will find here little that is new. Moreover, he will find the style at times a bit wordy. The author's point of view, however, occasionally yields a new idea of practical value, and the book may serve for nontechnical readers as a digest of "scientific management" literature.

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DESCRIPTIONS OF LAND: A Text-Book for Survey Students—By R. W. Cautley, Late Surveyor to the Land Titles Office at Edmonton, Alta., and Member, Alberta and British Columbia Boundary Commission. New York: The Macmillan Co. Cloth; 5x8 in.; pp. 89. $1.

Perhaps there can be no better statement of the intent of this book than that given by the author himself in the preface, an extract of which follows:

I have written the following textbook in the hope that it may prove useful in helping survey students to get up the subject for their examination (for government license), and what is far more important to realize the importance of the subject, and by further study of it to become capable of filling a more useful position as a surveyor in after life.

Writing descriptions of land is essentially a branch of surveying and every complicated description should be drawn by an authorized surveyor. Unfortunately, a great many surveyors are satisfied with obtaining proficiency in fieldwork as the most important and lucrative part of surveying, and do not take the trouble to become proficient in description writing, draftsmanship, survey law or any other kindred subject once they have obtained their commission.

I venture to say that any surveyor, having just acquired his commission, who will devote a year or two to acquiring a knowledge of office work and general business methods in a department of the government, in the land department of a railway system or in the employ of any corporation having extensive dealing in land, will find that the knowledge so obtained will open to him a wider field of opportunity and will more than compensate him for the increased earnings which he might have had by undertaking field work at once.

The book itself is divided into 13 chapters outlining methods of describing land boundaries based on actual survey, and how to reference descriptions to government plans of record; the use of natural boundaries in descriptions; use of the words "more or less" in descriptions; the use of bearings in descriptions; description of remainders; description by exception; of railway rights-of-way; of mineral lands; interpretation of faulty descriptions, and then a chapter on examples of descriptions of land including city lots, quarter-sections, parts bounded by rights-of-way, etc.

As noted in the preface, the book is intended for Canadian practice and for that reason is not of particular value to American surveyors and engineers; but many of the general principles involved are, of course, the same in American practice as in Canadian practice, and the book will therefore be a valuable addition to any surveyor's library.

ELECTRIC CAR MAINTENANCE—By Walter Jackson, Associate Editor, "Electric Railway Journal." New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. x + 275; 140 text figures. $3, net.

The contents of this book come very largely from the columns of *The Electric Railway Journal*. As this matter is the recorded experience of maintenance men scattered broadly over the country, "kinks" much of it, it is intensely practical and of vital everyday interest to railway officials in high and low position.

The various items naturally group themselves somewhat as follows: (1) mechanical appliances for train operation; (2) structural car-body parts and fittings; (3) brake fittings; trucks, etc.; (4) motors; electric control; heaters, lamps and auxiliaries; (5) collectors; (6) bearings and lubrication; (7) cleaning; (8) shop practice; (9) instruction prints.

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ENGINEERS' HANDBOOK of Tables, Charts and Data on the Application of Centrifugal Fans and Fan System Apparatus, Including Engines and Motors, Air Washers, Hot Blast Heaters and Systems of Air Distribution—Edited by Willis H. Carrier, Chief Engineer. Buffalo, N. Y.: The Buffalo Forge Co. Flexible leather; 4x7 in.; pp. 581; illustrated. $3.

The chief engineer of this well known manufacturing company has assembled a vast amount of useful information and data on the properties of air, heat loss from structures, heating and ventilation requirements, air cleaning and humidifying, drying, forced and induced draft in moving air, air ducts, fans, etc. Some of this is fundamental theory, some is statement of common practice and much is from the files of this manufacturing company—particularly those sections presenting the performance and dimensions of certain lines of apparatus.

## NEW PUBLICATIONS

[So far as possible the name of each publisher of books or pamphlets listed in these columns is given in each entry. If the book or pamphlet is for sale and the price is known by the editor the price is stated in each entry. Where no price is given it does not necessarily follow that the book or pamphlet can be obtained without cost. Many, but not all, of the pamphlets, however, can be secured without cost, at least by inclosing postage. Persons who are in doubt as to the means to be pursued to obtain copies of the publications listed in these columns should apply for information to the stated publisher, or in case of books or papers privately printed, then to the author or other person indicated in the notice.]

AMERICAN ROAD BUILDERS' ASSOCIATION—Proceedings of Convention, Philadelphia, Penn., Dec. 9-12, 1913, and Reports of the Executive Committee, Secretary and Treasurer Presented at Annual Meeting, Feb. 6, 1914. New York: E. L. Powers, Secretary, 150 Nassau St. Paper; 6x9 in.; pp. 320. $2.

THE AUTOCAR IMPERIAL YEAR BOOK, 1914—London (20 Tudor St.): Iliffe & Sons, Ltd. Cardboard; 8x12 in.; pp. 126; illustrated. 2½ shillings, net.

BUSINESS ADMINISTRATION; Its Models in War, Statecraft and Science—By Edw. D. Jones. New York: The Engineering Magazine Co. [Works Management Library.] Cloth; 5x8 in.; pp. vii + 275. $2, net.

CAMBRIA STEEL: A Handbook of Information Relating to Structural Steel Manufactured by the Cambria Steel Co., Containing Useful Tables, Rules, Data and Formulæ for the Use of Engineers, Architects, Builders and Mechanics—Prepared and Compiled by George E. Thackray, Special Engineer, Cambria Steel Co., Johnstown, Penn. Flexible leather; 4x7 in.; pp. x + 513; illustrated. $1.25.

CHECK LIST OF BIBLIOGRAPHIES RELATING TO MUNICIPAL GOVERNMENT—By Joseph Wright, Librarian of the Bureau for Research in Municipal Government, Harvard University, Cambridge, Mass. [Reprinted from the "National Municipal Review," April, 1914, Vol. III, No. 2.] Paper; 7x10 in.; pp. 20.

COAST SAND DUNES, SAND SPITS AND SAND WASTES—By Gerald O. Case, Consulting Engineer for Coast Works. London: St. Bride's Press, Ltd. Cloth; 5x8 in.; pp. 162; 43 illustrations. 5 shillings, net.

COX'S COMMERCIAL CALCULATOR; A Novel and Easy Method of Multiplication, One Formula for all Calculations, Range of Results from a Single Unit to Over Ten Billions, Automatic Index to Tables—By Edward L. Cox, Southport, Lancashire, England. New York: Fung & Wagnalls Co., and the Remington Typewriter Co. Linen; 7x11 in.; pp. 101. $10.

THE EFFECT OF THE SOOT IN SMOKE ON VEGETATION—By J. F. Clevenger. Smoke Investigation Bulletin 7, Mellon Institute of Industrial Research and School of Specific Industries. Pittsburgh, Penn.: University of Pittsburgh. Paper; 6x9 in.; pp. 26; illustrated.

ELEMENTARY EXPERIMENTAL DYNAMICS FOR SCHOOLS—By C. E. Ashford, Headmaster of the Royal Naval College, Dartsmouth. New York: G. P. Putnam's Sons. Cambridge, England: The University Press. Cloth; 5x8 in.; pp. 246; 94 illustrations. $1.25.

The author apologizes for the appearance of another book on dynamics by stating that this volume forms the second part of a rudimentary (or introductory) course of mechanics for schoolboys. We have previously discussed in "Engineering News," the unsuitable character of all academic treatises on physics (using the deductive method of course) for students approaching the subject for the first time. The author is to be commended for joining that growing school which brings common experiences of life and the laws of physics together in logical form and seeks to give young men a mental equipment that allows the scientific attack to be transferred from the laboratory to the field and shop or to the store and counting house.

ENGINEERING GEOLOGY—By Heinrich Ries, Professor of Economic Geology, Cornell University, and Thomas L. Watson, Professor of Economic Geology, University of Virginia, and State Geologist of Virginia. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 6x9 in.; pp. xxvi + 672; 175 illustrations. $4, net.

THE GEOLOGY OF LONG ISLAND, N. Y.—By Myron L. Fuller. Washington, D. C.: United States Geological Survey. Professional Paper 82. Paper; 9x12 in.; pp. 231; illustrated.

GREATER ERIE: Plans and Reports for the Extension and Improvement of the City—Prepared for the City Planning Committee of the Chamber of Commerce and the Board of Trade of Erie, Penn., by John Nolen, City Planner; E. P. Goodrich, Consulting Engineer, assisted by F. Van Z. Lane, Traffic Expert; Henry C. Long, and Legal Sub-Committee. Cardboard; 8x11 in.; pp. 254; illustrated.

THE IRON AND STEEL INDUSTRY—Prepared by the Industrial Bureau of the Merchants' Association of New York (Edward E. Pratt, Manager, Woolworth Building). Bulletin 1. Paper; 6x9 in.; pp. 33.

LIST OF PUBLICATIONS PERTAINING TO GOVERNMENT OWNERSHIP OF RAILWAYS—Washington, D. C.: Bureau of Railway Economics. Bulletin 62. Paper; 6x9 in.; pp. 74.

MARINE STEAM: Forged Steel Water-Tube Marine Boilers—The Babcock & Wilcox Co., 95 Liberty St., New York City. Second edition. Cloth; 7x10 in.; pp. 220; illustrated.

This book shows, of course, great preference for the practice of this company in the design and construction of steam boilers for vessels. There is, however, a great deal of interesting and useful general matter on marine use of steam—requirements of ideal boilers, dimensions of various types, use of fuels on shipboard, properties of steam, test data, etc.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY—(Boston, Mass.): Contributions from the Sanitary Research Laboratory and Sewage Experiment Station. Reprinted Papers. Vol. IX. Paper; 6x9 in. $1.

Seventeen papers on water and sewage treatment from the chemical and biological sides, on typhoid fever, foods, public health administration and other sanitary topics, by members of the Laboratory staff, or reprinted from various sources. There are several papers by Prof. Wm. T. Sedgwick and also several by Prof. Earle B. Phelps.

METALLURGY OF COPPER—By H. O. Hofman, Professor of Metallurgy, Massachusetts Institute of Technology. New York and London: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. xiv + 556; 548 illustrations. $5, net.

MITTEILUNGEN AUS DEM KÖNIGLICHEN MATERIAL-PRUFUNGSAMT zu Berlin-Lichterfelde West—Herausgegeben im Auftrage der Königlichen Aufsichts-Kommission. Parts 7 and 8, 1913. Berlin: Julius Springer. Paper; 8x11 in.; pp. 322-458; illustrated. Yearly price, 16 Marks.

MODERN CITY PLANNING AND MAINTENANCE—By Frank Koester, author of "Steam Electric Power Plants," "Hydroelectric Developments and Engineering" and "The Price of Inefficiency." New York: McBride, Nast & Co. Cloth; 7x10 in.; p. xix + 329; 200 illustrations. $6, net.

OFFICIAL RECORD OF THE FIRST AMERICAN NATIONAL FIRE PREVENTION CONVENTION, Philadelphia, Penn., Oct. 13-18, 1913.—Compiled by Powell Evans, Chairman. Philadelphia Fire Prevention Commission, Philadelphia, Penn. Paper; 6x9 in.; pp. 541. $1, postpaid.

OIL FUEL FOR STEAM BOILERS—By Rufus T. Strohm. Engineering Textbook Writer, International Correspondence Schools. [The Power Handbooks.] New York and London: McGraw-Hill Book Co., Inc. Cloth; 4x7 in.; pp. + 145; 63 text figures. $1, net.

This little manual sets forth the principles behind the use of fuel oil, design of burners and furnaces, operation of pumps and heaters, etc. No claims for originality seem to be made; the book is obviously a compilation, but with evident attempt to secure conciseness and simplicity.

RECENT DECISIONS REGARDING REASONABLE RATES FOR FIRE PROTECTION—By W. C. Hawley, M. Am. Soc. C. E., and Morris Knowles, M. Am. Soc. C. E. A Paper read before the Pennsylvania Water Works Association, Atlantic City, Oct. 24, 1913. Paper; 6x9 in.; pp. 19.

REINFORCED CONCRETE RAILWAY STRUCTURES—By J. D. W. Ball, Assoc. M. Inst. C. E. New York: D. Van Nostrand Co. [The Glasgow Text Books, Edited by G. Moncur.] Cloth; 6x9 in.; pp. xiv + 208; 127 illustrations. $2.50, net.

REPORT ON A PARK SYSTEM FOR LITTLE ROCK, ARK.—By John Nolen, Landscape Architect, Cambridge, Mass. Paper; 8x11 in.; pp. 30; illustrated.

RESEARCHES IN HYDRAULIC ENGINEERING—Bulletins of the University of Wisconsin Nos. 578, 596, 598 (by Leland Rella Balch, Research Assistant in Hydraulic Engineering), and No. 629 (by George Jacob Davis, Jr., Sometime Assistant Professor of Hydraulic Engineering, and Leland Rella Balch). Paper; 6x9 in.; illustrated. 25c. each.

Investigation of Hydraulic Curve Resistance Experiments with Three Inch Pipe. Pp. 52.
Test of a Jet Pump. Pp. 15.
A Test of an Eight Foot Flash Wheel. Pp. 53.
Investigation of Flow Through Large Submerged Tubes: Part III, Experiments with Submerged Draft Tubes. Pp. 57.

SANITARY OFFICERS OF THE STATE OF NEW YORK—Proceedings of the Annual Conference, Utica, N. Y., Nov. 19-21, 1913. Albany, N. Y.: New York State Department of Health, Division of Publicity and Education. Paper; 6x9 in.; pp. 178.

SEWER FLUSHING, With an Appendix on Sewage Pumping, Sewage Disposal and Sewer Jointing—Merritt Hydraulics Co., 112 No. Broad St., Philadelphia, Penn. Second edition. Paper; 6x9 in.; pp. 102; 146 illustrations.

A compilation of useful and suggestive text, tables and diagrams on Sewer Flushing, combined with trade catalog matter of merit.

STEAM SUPERHEATERS—New York: (85 Liberty St.) The Babcock & Wilcox Co. Cloth; 7x10 in.; pp. 80; illustrated.

One company's equipment is given great attention in this volume, as would be expected; there is, however, so much good material on the subject in general that the book is taken out of the catalog class.

SURFACE WATER-SUPPLY PAPERS—Washington, D. C.: U. S. Geological Survey. Paper; 6x9 in.; illustrated.
No. 306: Part VI, Missouri River Basin (1911). By W. A. Lamb, W. B. Freeman and Raymond Richards. Pp. 374.
No. 309: Part IX, Colorado River Basin (1911). By Robert Follansbee, W. B. Freeman and G. Clyde Baldwin. Pp. 266.
No. 322: Part II, South Atlantic Coast and Eastern Gulf of Mexico Basins (1912). By W. E. Hall and C. H. Pierce. Pp. 98.
No. 324: Part IV, St. Lawrence River Basin (1912). By C. C. Covert, A. H. Horton and W. G. Hoyt. Pp. 149.

TELEPHONE CONSTRUCTION, INSTALLATION, WIRING, OPERATION AND MAINTENANCE—By W. H. Radcliffe and H. C. Cushing, author of "Standard Wiring for Electric Light and Power." Second revised and enlarged edition. New York: The Norman W. Henley Publishing Co. Cloth; 4x7 in.; pp. viii + 223; 150 illustrations. $1.

This is the second edition of a handbook for the practical man, amateur, or contractor having to install construction-job telephone equipment only at intervals. The new material is on underground conduits, cables, poles, line methods, lamp annunciators and automatic selection.

TESTS OF BOND BETWEEN CONCRETE AND STEEL—By Duff A. Abrams. Bulletin 71, Engineering Experiment Station, University of Illinois, Urbana, Ill. Paper; 6x9 in.; pp. 238; illustrated. $1.

TECHNICAL PAPERS, U. S. BUREAU OF MINES—Washington, D. C. Paper; 6x9 in.
No. 69: Production of Explosives in the United States During 1912—Compiled by Albert H. Fay. Pp. 8.
No. 71: Permissible Explosives, Tested Prior to Jan. 1, 1914—By Clarence Hall. Pp. 12.

THEORY OF ARCHES AND SUSPENSION BRIDGES—By J. Melan, Professor of Bridge Design, German Technical School at Prague. Authorized Translation by D. B. Steinman, Professor of Civil Engineering, University of Idaho; author of "Suspension Bridges and Cantilevers." Chicago: The Myron C. Clark Publishing Co. London: E. & F. N. Spon, Ltd., 57 Haymarket. Cloth; 6x9 in.; pp. x + 303; 119 illustrations. $3.

DAS VERKEHRSPROBLEM DER GROSSSTADT MIT BERÜCKSICHTIGUNG WIENS—Von Privatdozent Dr.-Ing. Fritz Steiner. [Reprinted from "Osterr. Wochenschrift für den öffentl. Baudienst," Nos. 11 and 12, 1914.] Wien, Austria: R. v. Waldheim, Jos. Eberle & Co. Paper; 6x9 in.; pp. 41; 2 folding maps.

WATER-SUPPLY PAPERS—Washington, D. C.: U. S. Geological Survey. Paper; 6x9 in.; illustrated.
No. 340-A: Stream-Gaging Stations and Publications Relating to Water Resources, 1885-1913; Part I. North Atlantic Coast Drainage Basins. Compiled by B. D. Wood. Pp. 29.
No. 345-A: Preliminary Report on Ground Water for Irrigation in the Vicinity of Wichita, Kan. By O. E. Meinzer. Pp. 9.
No. 345-B: Ground Water for Irrigation in the Vicinity of Enid, Oklahoma. By A. T. Schwennesen. With a note on Ground Water for Irrigation on the Great Plains. By O. E. Meinzer. Pp. 23.
No. 345-C: Underground Water of Luna County, New Mexico. By N. H. Darton. With Results of Pumping Tests. By A. T. Schwennesen. Pp. 40.
No. 345-D: Ground Water for Irrigation in the Valley of North Fork of Canadian River near Oklahoma City, Okla. By A. T. Schwennesen. Pp. 51.

THE WET LANDS OF SOUTHERN LOUISIANA AND THEIR DRAINAGE—By Charles W. Okey, Drainage Engineer. Washington, D. C.: U. S. Department of Agriculture. Bulletin 71. Paper; 6x9 in.; pp. 82. 15c. a copy.